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Abstract

This paper studies how financial distress affects competition and how incumbent bankruptcy affects the growth of rivals, specifically in the context of airline bankruptcies. I begin by studying whether bankrupt airlines put competitive pressures on rivals by cutting fares and maintaining or expanding capacity on the 1000 most popular domestic routes from 1998-2008. The results suggest that, although bankrupt legacy airlines reduce fares, they also reduce capacities significantly. Low-cost carrier (LCC) rivals do not match the fare cuts and expand capacities by 13-18% above trend growth. The significant capacity reductions associated with legacy airline bankruptcies create growth opportunities for LCC rivals. This indicates the existence of barriers that have limited LCCs from expanding faster and more extensively. The LCC expansion during rivals' bankruptcies is even greater when I consider the 200 most popular airports instead of the 1000 most popular routes. During legacy airlines' bankruptcy, non-LCC rivals reduce capacities on the *routes* affected by the bankruptcy but expand at the affected *airports*. A likely explanation for this result is that non-LCCs avoid "bankruptcy" routes as more competitive pressure is expected with increasing presence of LCCs, but they pick up the gates or time slots given up by the bankrupt airlines to expand on other routes. On balance the total route capacity on the 1000 popular routes shows only a modest decrease during bankruptcy and eventually recovers, but the capacity mix changes in favor of LCCs. Overall, I find little evidence that distressed airlines toughen competition and lower industry profitability. LCC's capacity growth during legacy rivals' bankruptcy suggests the existence of market frictions in competition.

1 Introduction

This paper studies two separate but related topics by examining airline bankruptcies: one is the link between financial distress and market competition and the other is sticky market shares and new entrants' growth. In particular, we are interested in how bankrupt airlines behave, how their rivals respond, and how the industry changes as a result in the periods surrounding bankruptcies. The changes in market outcome over the course of bankruptcy inform how bankruptcy affects the strategic decisions of bankrupt airlines and their rivals and how incumbent airline bankruptcies affect the growth of their rivals. In addition, the differences in responses between different types of rivals will shed light on market structure in the industry.

We begin by studying whether bankrupt airlines harm their rivals to see how financial distress affects competition. In the United States, bankruptcies do not necessarily mean going out of business altogether. Unlike the liquidation bankruptcy of Chapter 7, Chapter 11 permits bankrupt firms to keep operating as a going-concern while reorganizing themselves under protection from creditors. Since Chapter 11 has been more of a rule than an exception in the airline industry and entering Chapter 11 can allow an airline to shed costs, critics have alleged that inefficient, bankrupt airlines survive and possibly harm even their healthier counterparts by lowering fares below what rivals charge and maintaining capacity. That is, it is often claimed that bankrupt airlines enjoy cost reductions by renegotiating contracts and hurt rivals' profitability by triggering fare wars and contributing to the chronic overcapacity problem of the industry. The ideas behind these arguments and related theories are detailed in Section 1.2. We focus on the potential harms of bankrupt airlines to rivals, especially by those of legacy carriers' bankruptcy to the low-cost carrier (LCC) rivals,[1] and examine whether those harms are realistic. In particular, we are interested in whether bankrupt airlines put competitive pressures on rivals to charge lower fares or shrink operations by cutting fares and maintaining or expanding capacities.

To evaluate the effect of own bankruptcy and the effect of the exposure of airlines to rivals' bankruptcy, we use panel data of fare and capacity on the 1000 most popular domestic routes for 42 quarters from 1998:Q1 to 2008:Q2. First, we examine how fares and capacities set by bankrupt airlines and their rivals change in pre-, during-, and post-bankruptcy periods, starting three quarters prior to a bankruptcy filing up to the end of the sampling period. In addition, since bankrupt airlines tend to reduce capacity (to cut total expenses) not only by cutting services on routes but also by withdrawing from routes altogether, we account for the exit of bankrupt airlines from routes and examine how fares and capacities of rivals change after the exit. To supplement the analysis, we also use the capacity data at the 200 most popular airports during the same period. We examine whether the total route capacity changes on balance over the course of bankruptcy.[2]

The empirical model is based on the assumption that the relative changes in fares and capacities set by bankrupt airlines' rivals are proportional to the degree of bankrupt airlines' market presence on a route in normal times, which allows for the effect to be different depending on the degree of exposure to a rival's bankruptcy. Likewise, we assume that the relative changes in the total route capacity are proportional to the market presence of bankrupt airlines on the route in normal times. We also divide the cases based on whether the bankrupt airline is a legacy carrier and whether bankrupt airline's rival is a LCC.

For legacy airline bankruptcies, we find that (1) bankrupt airlines cut fares as well as capacities significantly prior to bankruptcy filing and keep lower levels throughout bankruptcy procedures; (2) LCC rivals lower fares marginally only in the quarter of bankruptcy filing and then quickly return to normal

[1] There is no standard definition of a legacy or a low-cost carrier (LCC). A "legacy carrier" generally refers to an incumbent airline that has existed prior to the Airline Deregulation Act 1978 and primarily operates a hub-and-spoke system with an extensive route networks. A "low-cost carrier", on the other hand, generally refers to a relatively new airline which offers relatively cheap tickets with a low cost level and primarily provides point-to-point services. The terms legacy carriers, network carriers, and full-service airlines are often used interchangeably. Meanwhile, LCCs, point-to-point carriers, low-fare carriers, discount airlines, and no-frills carriers are usually different names for the same carrier group. See the Table 1 in Section 3.1 for the list of airlines by carrier group.

[2] Most airline bankruptcies were Chapter 11 filings. Many large legacy airline bankruptcies occurred only after 2000, and all of those filings were Chapter 11. While the data does not directly show the effect of immediate liquidation of a large legacy airline, we can expect what would have happened to the total route capacity under Chapter 7 by looking at what actually happened under Chapter 11 as bankrupt airlines, even when not liquidated, cut their capacities significantly.

fares during bankruptcy; (3) LCC rivals expand capacities and market shares over the course of bankruptcy and the LCC expansion is greater on the routes where bankrupt airlines used to have a larger market share; (4) non-LCC rivals tend to shrink on the routes where legacy carriers are bankrupt but expand at the airports where legacy carriers are bankrupt, indicating that they are picking up the gates and slots the bankrupt airlines are giving up but avoiding competition on "bankruptcy" routes. A likely explanation for this behavior is the expectation of rising competition with increasing LCC presence on those routes; (5) average fares fall eventually after a legacy carrier's bankruptcy or exit from a route, indicating toughened competition after, rather than during, bankruptcies. A likely explanation for this result is the increased presence of LCCs; and lastly, (6) the total route capacity shows a modest decrease in terms of the number of available seats over the course of bankruptcy and the number of scheduled flights is mostly unaffected during bankruptcy and even increasing in the post-bankruptcy periods, implying the replacement of large aircrafts with smaller ones. This suggests either that the overcapacity problem does not exist or that outright liquidation may provide a temporary resolution of the overcapacity problem, if any, but it will not be permanent as other airlines will expand to fill the gap. In sum, the findings uncover no evidence that bankrupt airlines toughen competition.

The findings are largely consistent with the previous studies on bankrupt airlines and their rivals, although previous research does not focus on the different responses between different groups of bankrupt airlines and rivals. Borenstein and Rose (1995) find that fare cuts by bankruptcy-filing airlines start prior to the actual filing but dissipate quickly during bankruptcy, and their rivals do not change fares significantly during the same period. The closest research to this paper, Ciliberto and Schenone (2008), looked at the changes in fare and capacity during and after Chapter 11 bankruptcies. They find that bankrupt airlines' rivals do not cut fares to match bankrupt airlines' fares. They also report that bankrupt airlines reduce capacity but their rivals marginally reduce or even increase capacity. Another paper by Borenstein and Rose (2003) finds no significant effect of bankruptcy on total services at small and large airports and, even at medium sized airports, the reduction is not large. Lastly, the case studies in the U.S. General Accounting Office (2005) show that, when dominant airlines reduce capacity substantially for some reasons such as filing for bankruptcy or dropping hub airports, the reduced capacity is quickly filled by other airlines.

The main lesson from the empirical results is that LCCs expand while bankrupt legacy airlines reduce capacities. The pattern of LCCs' replacement of bankrupt legacy airlines has two implications. First, the relative cost-efficiency of LCC rivals that replace bankrupt legacy airlines' capacity indicates improved allocative efficiency in production as the capacity composition changes in favor of LCCs. Second, more importantly, our findings suggest that the immediate and substantial capacity reduction by bankrupt airlines presents new opportunities for their efficient rivals to expand, which indicates the existence of barriers that have limited LCC growth, aside from product heterogeneity. This approach is different from previous analyses of LCCs that usually focus on how incumbents respond to LCC entry.[3] This study rather asks how LCCs would respond when incumbents contract under the extreme form of financial

[3] For example, Goolsbee and Syverson (2004) looked at how incumbent legacy airlines set fares and capacities when Southwest entry to a route gets more likely and suggested that the airlines lower fares to lock-in consumers through a frequent flyer program. The result indicates that a frequent flyer program can be a significant entry barrier in the airline industry.

distress, and thereby highlights the resilience of incumbents and the factors stimulating LCC expansion.

In the airline industry, LCC growth has been only modest considering the substantial cost advantages over incumbent legacy airlines and the long history since the deregulation in 1978. LCCs have grown mostly by creating and accommodating price-elastic demands that have not been served by incumbent legacy airlines. Does the limited growth mean LCCs are inferior to legacy carriers, with cheap fare and comparable cheap services? The growth of LCCs during legacy rivals' contraction suggests the existence of barriers that have hindered efficient entrants from taking markets away from incumbents. The barriers can be fixed resources, such as ground facilities and time slots, long-term and exclusive contracts on the use of the resources, or consumer inertia from switching costs established by various loyalty programs. These barriers could make it difficult for even efficient new entrants to challenge incumbents with a substantial market share. Patterns of past growth of LCCs can be useful in assessing the factors that spur or limit it. This leads us to an additional question: how large a fraction of LCC growth is spurred by rivals' bankruptcies and capacity reduction associated with them? We estimate the fraction in Section 1.7. The magnitude of the estimates will be informative of how high the barriers are.

We attempt to quantify the growth effect from rivals' bankruptcy. Based on the regression results, we calculate the counterfactual capacity levels of LCCs in the absence of bankruptcies and compare the counterfactual capacity growth of LCCs with the actual growth. For the entire sample of bankruptcies, we estimate the fraction of LCC growth from rivals' bankruptcy as 13-18% of the LCC growth in 1998:Q1 through 2008:Q2 (the data period). In particular, legacy airlines' bankruptcy explains about 11-17% of the growth and other (non-legacy) airlines' bankruptcy explains about 1% of the growth. Our most conservative estimate is over 10% of the growth. This means that the effect of rivals' bankruptcy accounts for a significant portion of the growth, implying that barriers are not negligible.

The remainder of this paper proceeds in the following steps. Section 1.2 specifies the background and motivation for the paper. Section 1.3 describes data sources and sample. Section 1.4 outlines a conceptual framework, identification strategy, and potential biases. Section 1.5 presents econometric specifications and Section 1.6 discusses estimation results. Section 1.7 calculates the fraction of the LCC growth spurred from rivals' bankruptcies. Finally, Section 1.8 concludes.

2 Background

This section introduces the background and motivation for the paper. There have been almost two hundred bankruptcy filings in the airline industry. Most of the bankruptcies have been Chapter 11 filings by small, new entrants which ended up with liquidation.[4] Unlike the bankruptcies of small airlines, those of large network carriers can have much stronger and wide-reaching effects on the industry. This paper investigates how bankruptcy affects rivals' strategic decisions on fare, capacity, and growth. We focus especially on legacy airline bankruptcies and how LCC and non-LCC rivals respond to the bankruptcy.

We begin by asking whether bankrupt airlines harm rivals, especially efficient ones characterized by low cost structures, and whether the industry efficiency and profitability deteriorate as a result. The following quote summarizes the worries over the potential harm of bankrupt airlines operating under

[4] United States General Accounting Office (2005) GAO-05-945: pp. 12-13.

Chapter 11.

> What's wrong with Chapter 11? It may keep ailing businesses going, but it distorts the airline industry: Chapter 11 businesses end up with unfair competitive advantages over competitors, thanks to their ability to renegotiate contracts, cut costs and dump debts. Worse, the most basic problem in the industry is excess capacity – too many seats and too few customers, something Chapter 11 doesn't help: all too often it lets airlines restructure without cutting back capacity. This means the core problem is never resolved.
>
> *Moneyweek, Dec 12, 2005*[5]

Some critics alleged that entering Chapter 11 will allow inefficient firms to shed costs and the bankrupt airlines will put competitive pressure on rivals. In particular, they argue that bankrupt airlines squeeze their rivals' profit margins and possibly harm even healthier airlines' financial health by triggering a fare war and maintaining capacity. There is also an argument that overcapacity has been a fundamental problem of the industry and it would have been resolved if the bankrupt airlines were to have been liquidated right away. We will study the link between financial distress and market competition by examining these arguments. As presented in the later sections, the empirical results do not support the accusation of bankrupt airlines' potential harm to rivals and the industry. In fact, the reduced presence of bankrupt airlines appears to open the windows of opportunity for their rivals to expand, which leads to a question: who replaces bankrupt airlines and what fraction of the growth of replacing airlines can be attributed to rivals' bankruptcy? We will return to this question later in this section.

In order to predict bankrupt airlines' behavior and their rivals' responses, we need to understand the incentives they have. First, would financial distress lead a firm to compete aggressively? When a firm's survival is at risk, the firm may engage in a price war in order to secure survival at the expense of profit maximization. Hendel (1996) built a model in which financially distressed firms use aggressive pricing as a source of internal financing to raise liquidity. Financially distressed firms may discount future profits more heavily as liquidation is more likely. Chevalier and Scharfstein (1996) showed that financially distressed firms, with a low discount factor, will not compete aggressively for market share. Empirically, the tendency to trigger a fare war under financial distress in the airline industry is reported by Busse (2002). On the other hand, Chevalier (1995) examined supermarket leverage buyouts (LBO's) and found the evidence suggesting that higher leverage lead to softer competition.

Even if bankrupt airlines reduce fares, it is unclear that the fare cuts would put competitive pressure on rivals. Financial distress usually weakens airlines' competitiveness. Whether bankrupt airlines' fare cuts will lead to tougher competition is uncertain. Financial distress may ruin a firm's reputation and.consumers may discount bankrupt airlines for safety issues, inconvenience, less valuable frequent flyer programs, or other negative perceptions about bankruptcy (Titman, 1984 and Titman & Maksimovic, 1991). Therefore, the fare discount by a bankrupt airline may not be so effective that it pushes their rivals to lower fares. On the other hand, when a firm is under financial distress, the financial status of rivals will relatively improve. Then, healthy rivals may even initiate aggressive pricing so as to eliminate the

[5] "US airlines hit turbulence - again", By Simon Wilson, Moneyweek, Dec 12, 2005 (http://www.moneyweek.com/investment-advice/us-airlines-hit-turbulence—again.aspx)

weakened bankrupt airlines that cannot afford to cut fares against them (Bolton and Scharfstein, 1990). Therefore, we need to see whether and when bankrupt airlines and their rivals cut fares significantly and how rivals respond to a bankrupt airline's exit from a market.

Although the cost reductions achieved under bankruptcy protection may allow bankrupt firms to cut fares below market rates, it is not obvious that bankrupt airlines will take advantage of the cost reductions to engage in aggressive pricing. An airline usually manages to cut expenses in the bankruptcy process, but the cost of debt will rise for the bankrupt airline when raising funds. That is, bankruptcy may also have an opposite effect on cost levels as bankrupt airlines will have to face higher costs of debt when raising money because investors require a higher return on investment to compensate the heightened risk. So, whether bankrupt airlines will cut fares will depend in part on how managers define their cost levels when setting fares. On the other hand, the reduction may not be enough for the airlines to compete with the low fare of low cost rivals.

Now, let us think about the total capacity level. Some argue that the cost reduction under Chapter 11 may allow bankrupt airlines to maintain capacity and the bankrupt airlines should have been liquidated to resolve the industry's chronic overcapacity problem of too many seats for too few passengers. The nature of competition in the airline industry is indeed easy to lead to overcapacity. Morrison and Winston (1995) pointed out cyclical demand and forecast error as main sources for overcapacity. For example, airlines order airplanes much ahead of the time when the airplanes are used, and they are more likely to order more airplanes when business is better than normal. The combination of huge fixed cost and relatively small marginal cost may lead airlines to supply seats as long as the fare covers variable costs, even up to the unprofitable, excessive level. The mobility of capacities between routes may worsen the problem as airlines respond to high demand by transferring their capacities to popular routes, leading to a crowded market even for the high demand.

Even if the overcapacity problem exists in the airline industry, it is doubtful that liquidation will solve the problem. Outright liquidation will solve the overcapacity problem on the condition that remaining airlines do not fill the slack after bankrupt airlines are gone. The condition will hold only if the products of bankrupt airlines are irreplaceable or other airlines do not have incentives to expand. It is unlikely that bankrupt airlines' services are unique and cannot be substituted by other airlines. In addition, airlines have incentive for capacity-building for several reasons. Since network size and flight frequencies are the qualities that consumers value, the economies of scale may give airlines additional reasons to expand. The airplanes, gates, and time slots are fixed at least in the short term, which creates an option value of holding on to those resources. Those resources remain even after the owner airline disappears and other airlines will be willing to take the ownership of them. Also, capacity can be used as a strategic device to deter entry. The incentives for capacity-building are not restricted to bankrupt airlines. Therefore, it is not likely that the overcapacity problem, if it exists, will be solved after some airlines are gone as others will enter or expand to fill the slack.

Our empirical results show that bankrupt airlines, even when not liquidated, start to cut back on capacity near bankruptcy, either by withdrawing services from routes altogether or by reducing seat supplies (with smaller airplanes or less frequent flight schedules). LCCs expand capacity while their rivals, especially legacy airlines, are in bankruptcy. As a result, the route total capacity does not seem to change in the long term.

The findings on capacity have two implications, one on the allocative efficiency in production and the other on LCC growth. First, if the total route capacity level remains unaffected but rivals replace bankrupt airlines' capacity, the composition of capacity will change. In this case, who would replace the capacity is an interesting question. If replacing airlines are relatively more efficient than bankrupt airlines, then allocative efficiency in production will improve as market shares change in favor of more efficient firms. The replacement pattern would depend on the substitutability with bankrupt airlines' products and rivals' ability to add capacity at low costs. Under the competition with differentiated products, the closest competitors will benefit most from bankrupt airlines' capacity cutback. If competition is more about price than product differentiation, on the other hand, the most efficient competitors with low cost structures are more likely to benefit. Our empirical results show that LCC expansion is prominent when their bankrupt rivals, especially legacy ones reduce capacity, suggesting that allocative efficiency of the industry improves.

Second, the empirical results indicate that LCCs can be substitutes for bankrupt airlines and, moreover, they are willing to and able to expand. This raises a question: what has been holding LCCs back from expanding faster and more extensively? In other words, what would be the factor that spurs LCC growth? Figure 1[6] shows the unit cost (excluding fuel cost[7]) differential between carrier groups. The unit cost level of LCCs is about 50-70% of that of legacy airlines. If fuel cost is included, the cost differential will be even larger.

Even with significant cost advantages over legacy airlines, LCCs have recorded a slower and more limited growth than expected given the long history of airline industry deregulation since 1978. In general, market shares are sticky and market dominance is persistent. The airline industry was not an exception. Until recently, LCC expansion has been focused on niche markets and demands that have not been served by incumbent airlines and on less popular, secondary airports. That is, LCC growth has occurred primarily in a limited range.

Why have LCCs not expanded that quickly or extensively? The reasons can be product differentiation or the existence of barriers to expansion. If travelers regard legacy carriers' services as superior to LCCs' (due to, for example, preference for extensive networks, more frequent flights, or other extra services), then LCCs would not have been able to take large markets away from legacy carriers. This paper is related to the branch of literatures on entry barriers. Switching costs from the Frequent Flyer Program (FFP) can act as an artificial entry barrier as in Farrell and Klemperer (2004). Goolsbee and Syverson (2004) find the evidence consistent with incumbents' incentives to cut fares and build consumer loyalty when Southwest entry gets more likely. Moreover, the resources essential for airline operations (such as airport gates and time slots) are fixed at least in the short term. Long-term contracts on the use of the resources can be a factor that limits LCC growth as in Aghion and Bolton (1987). Therefore, it would be hard to get access to the facility if incumbents do not give up their shares locked in long-term contracts.

The findings that LCCs replace bankrupt legacy airlines' capacities suggest that the obstacle for the growth is more likely to be the existence of barriers, that is, market frictions. Lower cost alone does not

[6]Source: Author's calculation based on the Airline Data Project established by the MIT Global Airline Industry Program

[7]Differences in CASM *excluding fuel costs* between carrier groups are compared because fuel costs may be affected more by external shocks than by endogenous managerial or operational efficiencies.

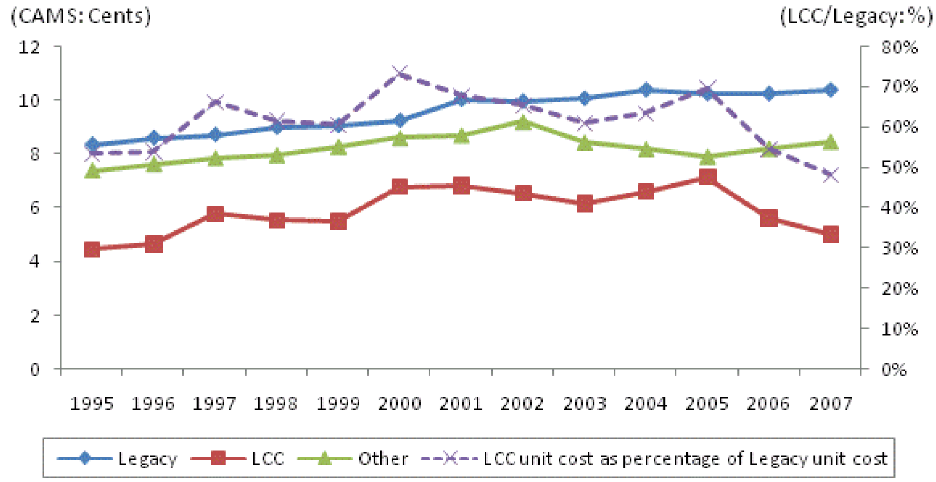

Figure 1: CASM (cost per available seat mile) Excluding Fuel Costs

guarantee that entrants will take markets from less efficient incumbents. Incumbents' discrete capacity cutback driven by bankruptcy or near-bankruptcy financial distresses can present immediate growth opportunities for those efficient airlines. For example, when a bankrupt legacy carrier reduces operations, some of the usual customers to the carrier will have to choose other airline. For those customers, other legacy carriers and LCCs may be thought of as providing homogeneous products. LCCs then face competition without switching costs. In this case, LCCs will be able to capture many those customers with low fares. Also, new physical resources may become available for LCCs to use as bankrupt airlines give up those resources. The fraction of LCC growth spurred by rivals' bankruptcy will be estimated in Section 1.7. The magnitude of the fraction will inform us about how high the barriers are in the airline industry.

3 Data

3.1 Data Sources and Sample Construction

There are two main data sources used in the analysis: the Airline Origin and Destination Survey Data Bank 1B (DB1B) and the Air Carrier Statistics database (T-100 data bank). Both are available from the Bureau of Transportation Statistics of the U.S. Department of Transportation.[8] First, the Airline Origin and Destination Survey DB1B is a 10% (random) sample of airline tickets from reporting carriers collected by the Office of Airline Information of the Bureau of Transportation Statistics. The quarterly data set includes origin, destination and other itinerary details such as ticket price, number of passengers transported, ticketing carrier, operating carrier, distance of the itinerary, number of connections (number of coupons used in a itinerary), whether the ticket is for a round trip, etc.[9]

[8] http://www.transtats.bts.gov/

[9] The data is recorded when a ticket is used, but not when it is purchased. As travelers plan their trip ahead and book tickets, there may be a time lag between the changes in an airline's competitive behavior and the market outcome. However, since the data set is quarterly, if most people buy tickets within one or two months ahead of the time of actual flight, this may not be a big problem.

Second, we restrict our attention to U.S. domestic passenger airlines[10] and domestic markets, and so we use T-100 Domestic Market (U.S. Carriers) and T-100 Domestic Segment (U.S. Carriers) data from the Air Carrier Statistics database. The "market" data includes monthly air carrier passenger traffic information by enplanement for operating carrier-origin-destination combination each time period. The "market" data records the passengers that enplane and deplane between two specific points, regardless of the number of connections between the two points in the itinerary. This market definition is comparable to the origin and destination pair in DB1B. On the other hand, the "segment" data contains the number of seats available, the number of scheduled departures, and departures performed, by operating carrier, origin, and destination. Unlike in the "market" data, the "segment" is composed of a pair of points served or scheduled by a single stage.[11]

A route is defined as a pair of origin and destination (on an airport basis), and each route is regarded as a market. A route is treated in a direction-manner in the sense that, if origin and destination airports are switched, it is considered to be a different route. Direction matters because demand conditions can be different even between the same two endpoints, depending on which way passengers are heading.[12] Using the T-1000 Domestic Market database, we pick the 1000 most popular routes in each quarter from 1998:Q1 through 2008:Q2 in terms of passenger enplanements. The 1000 routes represent a significant portion of airline market demand. For instance, in 2007, the number of passengers who travelled the 1000 most popular routes is about 60% of the total demand. In addition, we pick the quarterly 200 most popular airports (in terms of the number of passengers flying out of the airport) in the same way. The 200 airports cover over 99% of the total number of originating passengers.

We mainly rely on the "route sample" that includes the quarterly 1000 most travelled routes for forty two quarters from 1998:Q1 through 2008:Q2 as a route represents a market (in which airlines directly compete) better than an airport. The "airport sample" which covers the 200 most popular airports will also be used to confirm and supplement the findings from the main route sample. The route sample will inform us about the change in market competition. The airport sample, on the other hand, will better represent the fixed resources that are allocated between airlines. The route sample includes fare, capacity, market share, and so on, while the airport sample does not include fare data. Capacity is mostly measured by the number of available seats, but scheduled departures (number of flights) and available seat miles (ASM) will also be used as other capacity measures.

[10] Airlines used in the study are the scheduled passenger airlines. Thus, charter, freight and taxi airlines are excluded.

[11] For example, if Southwest operates only connecting flights from San Francisco airport (SFO) to Chicago Midway airport (MDW), the flights will be recorded in DB1B and the "market" data, but not in the "segment" data.

[12] For example, when Super Bowl is held in Tampa, Florida, demand levels for tickets going to and coming from Tampa may be different.

Table 1.1: Airline List by Carrier Group

Carrier group	Carrier Name	Code	Status*
	American Airlines	AA	
	Continental Airlines	CO	
	Delta Airlines	DL	Reemerged from bankruptcy
Legacy	Northwest Airlines	NW	Reemerged from bankruptcy
	United Airlines	UA	Reemerged from bankruptcy
	US Airways	US	Reemerged from bankruptcy twice
	Alaska Airlines	AS	
	Trans World Airlines	TW	Bankrupt then acquired by American
	Southwest Airlines	WN	
	ATA Airlines	TZ	Reemerged but liquidated later
	JetBlue Airways	B6	
Low Cost	AirTran Airways	FL	
	Frontier Airlines	F9	Under Ch 11
	Spirit Airlines	NK	
	American West Airlines	HP	Merged with US
	Midway Airlines	JI	Liquidated
Others	Midwest	YX	
	Hawaiian Airlines	HA	Reemerged from bankruptcy

* Status change from 1998 to 2008

As for local economic conditions, we include employment, personal income, and population. Supplemental data on local economic conditions comes from the Regional Economic Accounts at the Bureau of Economic Analysis.[13] The data set, however, is rather limited. First, the data set covers only Metropolitan Statistical Areas (MSA) on a *yearly* basis up to 2007. So, it does not include Puerto Rico, Virgin Islands, and some cities in Hawaii and Alaska in the main sample. For about 96% of the main sample, both of the two endpoints of a route are MSAs. Due to less frequency and coverage of the data compared to the main sample, we report the estimation results both with and without local economic conditions.

The observation unit in DB1B is itinerary level. We aggregate the observations to carrier level using the number of passengers as a weight. As a result, in the final sample, we have one observation for a (ticket) carrier[14] on a route (or at an airport) in a given time (year, quarter). In the analysis on the total route capacity, itinerary level observations are aggregated to the route level so that we have one observation for a route in a given time. Again, observations are weighted by the number of passengers.

[13] http://www.bea.gov/regional/reis/default.cfm?selTable=CA1-3&section=2

[14] A ticket carrier is the airline that sold a ticket for an itinerary while an operating carrier is the airline that operated the flight. A ticket carrier and an operating carrier can be different for the same itinerary. We choose a ticket carrier over an operating carrier because the ticket carrier sets fares.

In addition, we drop observations if a carrier has less than 1% of the passengers on a route (or less than 1% of the capacity at an airport) in a given time, the (one-way) fare is less than 20 dollars, or an itinerary involves more than 4 connections in a one-way trip or more than 8 connections in a round trip. All fares used in analysis are inflation adjusted in 2000 dollars.[15] Table 1.1 is the list of main airlines in the final data set by carrier group. These eighteen carriers account for about 98% of the sample.[16]

We treat the airlines with different codes as separate carriers. So, a subsidiary of a large airline will be regarded as a separate airline. This is not much relevant especially in the route sample, because those subsidiaries usually operate on small, less populated routes that are not included in our main sample. Also, American West (HP) and US Airways (US) spent over a year after their merger announcement before they began using the same code. During the period between the announcement and the actual merger, the two airlines are treated separately.[17]

To identify bankruptcy events, we rely on the Lynn M. LoPucki's Bankruptcy Research Database (BRD)[18] and the "U.S. Airline Bankruptcies & Service Cessations" listed on the Air Transportation Association (ATA) website.[19] The BRD contains Chapter 11 filings of public companies with assets over $100 million that are required to file a form 10-K with SEC. The list of bankruptcy filings on ATA web page includes both Chapters 7 and 11, regardless of the size of a bankrupt airline. However, it says the list is "loose, unofficial". When the dates of bankruptcy filing, reemergence, or service cessation do not match between the two sources, we searched for online news articles on a specific bankruptcy event and picked the more accurate one. From these sources, we construct the history of airline bankruptcies during the data period.

Table 1.2 shows all bankruptcy events that we cover in the analysis. There are twenty one bankruptcy filings in the sample. Among those filings, bankrupt airlines survived in ten cases, went out of business after bankruptcy protection in nine cases, and ceased operations immediately in two cases. It is noteworthy that all six legacy airline bankruptcies are Chapter 11 filings and only one of the bankrupt legacy airlines has been liquidated.[20]

[15] Consumer Price Index - All Urban Consumers is available at http://data.bls.gov/cgi-bin/surveymos.

[16] For the list of LCCs, refer to Darin Lee's webpage (http://www.darinlee.net/data/lccshare.html).

[17] Though not reported in this paper, treating them as one airline after a merger announcement makes little difference in the empirical results.

[18] http://www.webbrd.com/bankruptcy_research.asp

[19] http://www.airlines.org/economics/specialtopics/USAirlineBankruptcies.htm

[20] Trans World Airlines (TW) filed for bankruptcy protection for three times and ended up with liquidation at the final attempt.

Table 1.2: Airline Bankruptcy Filings (1998 through 2008)

Carrier Name	Date of Filing	Ch.	Date of Reemergence	Date of Service Cessation
Kiwi International (KP)	Mar 23, 1999	11		Dec 8, 1999
Eastwind Airlines (W9)	Sep 30, 1999	7		
Tower Air (FF)	Feb 29, 2000	11		Dec 7, 2000
Pro Air (P9)	Sep 19, 2000	11		Sep 19, 2000
National Airlines (N7)	Dec 6, 2000	11		Nov 6, 2002
Midway Airlines (JI)	Aug 14, 2001	11		Oct 30, 2003
Trans World Airlines (TW)*	Jan 10, 2001	11		Dec 1, 2001
Sun Country Airlines (SY)**	Jan 8, 2002	7	April 15, 2002	
Vanguard Airlines (NJ)	July 30, 2002	11		Dec 19, 2004
United Airlines (UA)	Dec 9, 2002	11	Feb 2, 2006	
US Airways (US) 1st	Aug 11, 2002	11	Mar 31, 2003	
Hawaiian Airlines (HA)	Mar 21, 2003	11	June 2, 2005	
ATA Airlines (TZ) 1st	Oct 26, 2004	11	Feb 28, 2006	
US Airways (US) 2nd	Sep 12, 2004	11	Sep 27, 2005	
Aloha Airlines (AQ) 1st	Dec 30, 2004	11	Feb 17, 2006	
Delta Airlines (DL)	Sep 14, 2005	11	April 25, 2007	
Northwest Airlines (NW)	Sep 14, 2005	11	May 18, 2007	
Independence Air (DH)	Nov 7, 2005	11		Jan 5, 2006
Aloha Airlines (AQ) 2nd	Mar 31, 2008	7		
ATA Airlines (TZ) 2nd	April 3, 2008	11		April 3, 2008
Frontier Airlines (F9)	April 10, 2008	11		

* Trans World is merged by American,

** Sun Country's bankruptcy procedure was converted from Ch.7 to Ch.11

3.2 Summary Statistics

Tables 1.3 and 1.4 show summary statistics for the route sample (quarterly 1000 most popular routes) and the airport sample (quarterly 200 most popular airports), respectively. Definitions of the variables are in Table 1.6 in Section 1.5.1 In the tables, the first column is for the entire sample, and the other columns compare the data in "normal" times (columns labeled as "Normal") and during bankruptcy (columns labeled as "DuringB") for bankrupt airlines. Bankrupt airlines are divided into two groups depending on whether the bankrupt airline is a legacy carrier or not. By "normal" times, we mean one year (four quarters) prior to bankruptcy filing or before (that is, the periods before affected by bankruptcy). In other words, we exclude the observations during the period from three quarters prior to bankruptcy filing to the end of sampling period. Note that the data on capacity is available only for direct flights and thus the sample size (N_sgmt) is smaller for the capacity variables (N_seats, $N\_flights$, and $Seat\_share$).

Also, including local economic conditions (Emp_origin, ..., Pop_dest) lead to a smaller sample size (N_local) as they are restricted to MSAs until 2007:Q4.

Table 1.3 shows that bankrupt legacy airlines ("Legacy") tend to have lower fares and capacity levels during bankruptcy as compared to in the normal times. They also have smaller market presence (Mkt_share and $Seat\_share$) during bankruptcy than normal. It is noteworthy that the fraction of routes exposed to the competition from LCCs such as Southwest is higher during bankruptcy than before (see $LCCin$ and $SWin$). On the other hand, bankrupt non-legacy airlines ("Other"; usually a LCC or a regional carrier) tend to have lower fares but more capacities. We can see that the airport sample shows the same pattern (see Table 1.4). Although the comparison of summary statistics between the normal times and the periods during bankruptcy can be informative, we need a more rigorous empirical analysis to disentangle various confounding factors, which we will discuss in the next section.

Table 1.3: Summary Statistics - Route Sample

Panel 1: Carrier-level observations

		Bankrupt Airlines			
		Legacy		Other	
Variable	All	Normal	DuringB	Normal	DuringB
N_seats	64.819	72.437	64.430	50.661	59.900
[unit:1000 seats]	(50.100)	(54.157)	(47.015)	(55.676)	(51.666)
$N\_flights$	456.715	473.553	435.865	370.425	405.502
[1 departure]	(372.65)	(337.216)	(296.353)	(460.852)	(426.345)
Med_fare	131.74	143.55	128.85	137.81	123.93
[2000$]	(50.78)	(59.63)	(41.92)	(48.28)	(43.12)
$Q1\_fare$	102.24	107.44	99.05	114.00	106.25
[2000$]	(35.10)	(37.91)	(28.82)	(36.81)	(37.37)
$Q3\_fare$	192.46	224.24	184.59	176.66	152.73
[2000$]	(98.09)	(121.03)	(76.02)	(65.56)	(52.17)
Mkt_share	.228	.215	.189	.156	.172
[1]	(.270)	(.273)	(.245)	(.167)	(.187)
$Seat\_share$	.476	.539	.495	.290	.330
[1]	(.309)	(.321)	(.290)	(.202)	(.223)
$LCCin$	.718	.591	.693	.929	.884
	(.194)	(.491)	(.461)	(.255)	(.319)
$SWin$	.258	.165	.218	.174	.216
	(.437)	(.371)	(.413)	(.379)	(.412)
$Network$	.443	.556	.542	.093	.069
[1/1000]	(.194)	(.135)	(.125)	(.046)	(.048)
$Direct$	.509	.447	.451	.495	.528
[1]	(.418)	(.397)	(.403)	(.456)	(.446)
N	182,437	49,006	21,307	7,916	1,352
N_sgmt	82,333	19,690	7,767	3,386	609

Standard deviations are reported in parentheses. N: sample size

N_sgmt : nonstop-flight-only sample size (capacity data only available for the segment sample)

Panel 2: Route-level observations

Variable	Mean (SD)	Variable	Mean (SD)	Variable	Mean (SD)
N_seats_all	134.010	*Distance*	853.28	*Inc_dest*	171.72
[unit:1000 seats]	(77.146)	[1 mile]	(608.98)	[10^6 2000$]	(169.24)
N_flights_all	1120.873	*Emp_origin*	2440.93	*Pop_origin*	4893.09
[1 departure]	(640)	[1000]	(2047.31)	[1000]	(4394.42)
LCCin	.660	*Emp_dest*	2441.33	*Pop_dest*	4893.02
	(.473)	[1000]	(2042.23)	[1000]	(4382.51)
SWin	.287	*Inc_origin*	171.78		
	(.452)	[10^6 2000$]	(169.74)		
N_sgmt	41,993	*N_local*	38,678		

Standard deviations are reported in parentheses.

N_sgmt: nonstop flight only sample size (capacity data only available for the segment sample)

N_local: size of the sample with local economic conditions (98:Q1-07:Q4, MSA only)

Table 1.4: Summary Statistics - Airport Sample

		Bankrupt Airlines			
		Legacy		Other	
Variable	All	Normal	DuringB	Normal	DuringB
N_seats	.148	.228	.202	.103	.126
[unit:10^6]	(.447)	(.691)	(.578)	(.200)	(.200)
ASM	1.190	1.874	1.954	.726	1.140
[10^6 seat mile]	(3.949)	(5.613)	(5.454)	(1.577)	(1.805)
N_flights	1.339	1.590	1.408	.941	.865
[1 departure]	(3.509)	(4.606)	(3.952)	(1.943)	(1.476)
Mkt_share	.134	.173	.107	.111	.134
[1]	(.170)	(.194)	(.127)	(.184)	(.206)
Seat_share	.133	.173	.107	.110	.134
[1]	(.169)	(.193)	(.129)	(.183)	(.203)
LCCin	.806	.767	.887	.932	.883
	(.394)	(.422)	(.315)	(.250)	(.321)
SWin	.432	.430	.517	.428	.444
	(.495)	(.495)	(.499)	(.494)	(.497)
Emp	1239.94	1351.77	1514.40	1517.36	2491.91
[1000]	(1847.01)	(1861.85)	(1895.20)	(1971.38)	2520.95)
Inc	93.56	91.96	122.50	110.05	202.59
[10^6 2000$]	(162.60)	(148.15)	(178.70)	(160.17)	(226.32)
Pop	2498.24	2694.66	3060.58	3030.79	5113.9
[1000]	(3911.91)	(3923.64)	(4046.29)	(4179.01)	(5429.80)
N_sgmt	59,359	9,448	3,470	2,136	344
N_local	51,950	8,785	3,171	1,879	230

Standard deviations are reported in parentheses, *N_sgmt*: sample size

N_local: size of the sample with local economic conditions (98:Q1-07:Q4, MSA only)

4 Conceptual Framework and Identification

This section outlines a conceptual framework of the paper, raises identification issues, and discusses how to deal with those issues. We are interested in evaluating the effects of bankruptcy on airlines. The central questions are, first, how bankrupt airlines change fares and capacities (i.e. effect of own bankruptcy), second, how bankrupt airlines' rivals change fares and capacities in response (i.e. effect of the exposure to rivals' bankruptcy) and, lastly, how the total route capacity level changes (or does not change) as a result.

We depend on the concept of "average treatment effect on the treated" to describe a conceptual framework of empirical analysis. We begin by defining the potential outcomes with and without bankruptcy. In fare and capacity analysis for bankrupt airlines and their rivals, an individual is defined as a carrier-route-time combination labeled with irt and the outcome of interest is fare or capacity set by a carrier i on route r at time t (Y_{irt}). Airlines can be involved in bankruptcy in two ways: they file for bankruptcy themselves or they compete with bankrupt airlines. There are two potential outcomes depending on whether an airline is bankrupt or not (bankrupt-carrier indicator: $D_{it} = 1$ if a carrier i is bankrupt at time t and 0 otherwise). Also, there are two potential outcomes depending on whether an airline is a rival to bankrupt airlines or not (bankruptcy indicator: $W_{rt} = 1$ if bankrupt airlines are serving route r at time t and 0 otherwise). $Bshr_{rt}$ is the "normal" market presence of bankrupt airlines on route r at time t, that is, how dominant the bankrupt airlines used to be on the route. For rivals, we include $Bshr_{rt}$ to allow for the effect to vary depending on the degree of exposure to bankruptcies. For instance, when an airline used to be dominant on a route, its bankruptcy may have larger effects on the rivals competing on the route. We want to estimate the relative difference between the actual and counterfactual fare or capacity levels. To be more specific, we are interested in identifying the relative change in Y_{irt} upon bankruptcy:

$$\begin{aligned}\tau_{Bankrupt} &\equiv E\left[\log \frac{Y_{irt}(D_{it}=1)}{Y_{irt}(D_{it}=0)} \mid D_{it}=1\right] \\ &= E[\log Y_{irt}(D_{it}=1) - \log Y_{irt}(D_{it}=0) \mid D_{it}=1]\end{aligned}$$

for bankrupt airlines and

$$\begin{aligned}\tau_{Rival}(b) &\equiv E\left[\log \frac{Y_{irt}(W_{rt}=1)}{Y_{irt}(W_{rt}=0)} \mid W_{rt}=1, Bshr_{rt}=b\right] \\ &= E[\log Y_{irt}(W_{rt}=1) - \log Y_{irt}(W_{rt}=0) \mid W_{rt}=1, Bshr_{rt}=b]\end{aligned}$$

for the rivals competing against the bankrupt airlines.

As the log difference is approximately the same as the percentage change, $\tau_{Bankrupt}$ is interpreted as the percentage change in Y from own bankruptcy and τ_{Rival} is regarded as the percentage change in Y from rivals' bankruptcy. The rationale for choosing relative change over absolute change is that fare or capacity levels will be different on different routes, and we expect the bankrupt airlines to change fares and capacities proportionally to the usual levels on each route rather than by the same amount on every route.[21]

Ideally, we want to measure fare and capacity with and without bankruptcies for an identical unit, that is, for the same airline on the same route at the same time period. If we can observe the same individual with and without bankruptcy, we can simply compare the two outcomes (fare or capacity) with and without bankruptcy to see the bankruptcy effect. For example, a difference between the (log) fare/capacity averages with and without bankruptcy will represent the bankruptcy effect. Unfortunately, we can observe only what has been realized and we do not have data on potential outcomes unrealized. That is, we either observe fare/capacity of airline i on route r at time t with bankruptcy or without bankruptcy. This is where the unconfoundedness assumption plays a part. Unconfoundedness can be expressed as

$$\begin{aligned} D_{it} \perp\!\!\!\perp Y_{irt}(D_{it} &= 1), Y_{irt}(D_{it} = 0) \; | X_{irt} \\ W_{rt} \perp\!\!\!\perp Y_{irt}(W_{irt} &= 1), Y_{irt}(W_{irt} = 0) \; | X_{irt} \end{aligned}$$

where X_{irt} is a set of covariates that can affect the outcomes, fare or capacity. The condition means that own bankruptcy ($D_{it} = 1$) and rivals' bankruptcies ($W_{irt} = 1$) are randomly assigned given the observables, X_{irt}. In other words, given X_{irt}, the bankrupt carrier indicator and the bankruptcy indicator are exogenous and there are no confounding factors that are associated with both Y (fare and capacity) and the bankrupt-carrier and bankruptcy indicators, D_{it} and W_{rt}. This enables us to identify $\tau_{Bankrupt}$ and τ_{Rival}. The validity of the unconfoundedness assumption will depend on how effectively we can control for potential endogeneity. To assure unconfoundedness, we exploit the panel structure of the data set by employing a fixed effects model. In this way, time-invariant individual effects will be accounted for. If endogeneity and selection bias are restricted to time-invariant components, conditioning on individual fixed effects will be sufficient for the condition to hold. Otherwise, we will need to control for other time-variant factors responsible for endogeneity and selection bias, which will be discussed later in this section.

Under the unconfoundedness assumption, we can rewrite the bankruptcy effects as follows:

$$\begin{aligned} \tau_{Bankrupt} &= E\left[E[\log Y_{irt}|D_{it} = 1, X_{irt}] - E[\log Y_{irt}|D_{it} = 0, X_{irt}]\right] \\ \tau_{Rival}(b) &= E\left[E[\log Y_{irt}|W_{rt} = 1, Bshr_{rt} = b, X_{irt}] - E[\log Y_{irt}|W_{rt} = 0, X_{irt}]\right] \end{aligned}$$

where the outer expectation is taken with respect to the distribution of X_{irt}.

To model fare and capacity for parametric estimation, we assume that (1) the percentage change in fares and capacities set by bankrupt airlines are homogeneous on all routes where those airlines are serving, (2) the percentage change in fares and capacities set by bankrupt airlines' rivals are proportional to the degree of bankrupt airlines' market presence/dominance on a route, (3) the effects of covariates in X_{irt} on Y_{irt} are the same regardless of bankruptcy, and (4) the log-transformed outcome $\log Y_{irt}$ can be

[21] Though not reported here, the same analysis has been done to estimate absolute change instead of relative change and the results are not different qualitatively.

expressed as a linear function. Then, we have

$$\log Y_{irt} = \alpha_0 + \alpha_1 D_{it} + \alpha_2 W_{irt} Bshr_{rt} + X_{irt}\beta + \varepsilon_{irt}$$

where $\{\alpha_0,\ \alpha_1,\ \alpha_2,\ \beta\}$ is a set of parameters to be estimated and ε_{irt} is a random error with mean zero conditional on RHS variables. Then, the estimands of interest are simplified to

$$\begin{aligned}\tau_{Bankrupt} &= \alpha_1 \\ \tau_{Rival}(b) &= \alpha_2 b\end{aligned}$$

which can be estimated consistently by regressing $\log Y_{irt}$ on 1, D_{it}, and $W_{irt}Bshr_{rt}$.

Likewise, we want to identify

$$\begin{aligned}\tau_{Route}(b) &\equiv E\left[\log\left(\frac{Y_{rt}(W_{rt}=1)}{Y_{rt}(W_{rt}=0)}\right) \mid W_{rt}=1, Bshr_{rt}=b\right] \\ &= E[\log(Y_{rt}(W_{rt}=1)) - \log(Y_{rt}(W_{rt}=0)) \mid W_{rt}=1, Bshr_{rt}=b]\end{aligned}$$

for the total route capacity, where Y_{rt} is the total route capacity on route r at time t and W_{rt} and $Bshr_{rt}$ are the same as defined as before. We will refer to the routes that bankruptcy-filing airlines are serving as "bankruptcy" routes. We are interested in how the total route capacity changes (or does not change) over the course of bankruptcy. As in the model for carrier-level fare and capacity, we assume that the percentage change in the total route capacity on "bankruptcy" routes is proportional to the degree of bankrupt airlines' presence on the route and model the log-transformed value of total route capacity as a linear equation accordingly:

$$\log Y_{rt} = \gamma_0 + \gamma_1 W_{irt} Bshr_{rt} + Z_{rt}\delta_0 + \varepsilon_{rt}$$

where Z_{rt} is a set of route characteristics that may be associated with the total route capacity and bankruptcy of a carrier serving on route r (to assure the validity of the uncounfoundedness assumption), $\{\gamma_0,\ \gamma_1,\ \delta_0,\ \delta_1\}$ is a set of parameters to be estimated, and ε_{rt} is a random error with mean zero conditional on RHS variables. Combined with the unconfoundedness assumption ($W_{rt} \perp\!\!\!\perp Y_{rt}(W_{irt} = 1), Y_{rt}(W_{irt}=0))|Z_{rt})$, the model enables us to identify the change in the total route capacity with and without bankruptcy, i.e.

$$\tau_{Route}(b) = \gamma_1 b$$

by regressing $\log Y_{rt}$ on 1, $W_{irt}Bshr_{rt}$, and Z_{rt}.

In addition, we look at the exit of bankrupt airlines from a route to see how the exit affects rivals. Our empirical results and anecdotal evidence suggest that bankrupt airlines shrink operations either by reducing capacity on a route or by withdrawing services from a route altogether. The exit event will give us the opportunity to expect what would have happened if a bankrupt airline is liquidated instead of entering Chapter 11 protection. The effect of bankrupt airlines' exit from a route can be expressed in the same way as the bankruptcy effects are represented above. The exit events are not a random experiment of liquidation effect on rivals because a bankrupt airline made the decision to withdraw from the market or creditors found the airline unprofitable to keep operating. However, it will inform us of what actually happens when a bankrupt airline is gone (at least temporarily), supplementing the evidence from the comparison between actual and counterfactual behaviors of airlines affected by bankruptcies.

So far, we did not divide bankrupt airlines and rivals depending on which carrier group they belong to for a simple presentation of the identification problem. In the empirical analysis, we will separate the bankruptcy filings depending on whether a bankrupt airline is a legacy carrier or not. We will then divide bankrupt airlines' rivals depending on whether the rival is a LCC or not. Moreover, we allow for the bankruptcy effects to vary over the course of bankruptcy by estimating the changes in each event period separately (starting from pre-bankruptcy periods near bankruptcy to post-bankruptcy periods after reemergence, if applicable, from bankruptcy). This division of bankruptcy cases and periods does not change the implications of the identification problems and models stated above. The specific variable constructions are detailed in Section 1.5.1, and the empirical specifications are presented in Section 1.5.2.

A sufficient number of observations unaffected by bankruptcy will allow us to estimate the counterfactual patterns of fare and capacity set by airlines. The data for estimating the counterfactuals are from two sources: the data from the periods unaffected by bankruptcy (prior to bankruptcy) and the data from routes where no airline is bankrupt. For bankrupt airlines, we compare fare and capacity set by the physically identical carriers at different times (one before and the other after affected by bankruptcy). For their rivals, the comparison will be done for identical carriers both over time and cross-sectionally (between the routes where some rivals are bankrupt and those where no airline is bankrupt). We have at least five quarters ahead of every bankruptcy filing, and we have more than two years ahead of bankruptcy filings for most bankruptcy filings. Among the quarterly 1000 most popular routes used in the analysis, at least some routes are not affected by bankruptcy (and this is true for the quarterly 200 popular airports used for supplementary analysis).

We adopt the event study approach for empirical analysis. The basic idea is that we compare fare or capacity for bankruptcy-affected airlines and routes (bankrupt airlines, their rivals, and "bankruptcy" routes) to the normal counterparts unaffected by bankruptcy. The normal counterparts refer to the counterfactuals absent bankruptcy events. The key to the identification is unbiased estimation of the counterfactuals in absence of bankruptcies. As stated previously, we add individual fixed effects, considering that time-invariant individual heterogeneity may be responsible for potential endogeneity.

Now, we will discuss five issues that may lead to potential biases in estimating counterfactuals absent bankruptcies due to time-variant factors, and the best available options to lessen the potential biases one by one. First, as bankruptcy filing airlines will begin to experience financial distress at some point prior to actual bankruptcy filing, this may alter the airlines' behavior even prior to the actual bankruptcy filing. Kennedy (2000) examined the operating performance of bankruptcy filing firms and their rivals and found that the majority of declines in performance of bankrupt firms and their competitors occur in the periods close to the filing or in the early stage of bankruptcy. So, treating pre-bankruptcy periods as normal times may bias the estimates of bankruptcy effects downwards. In this case, separate estimation of pre-bankruptcy periods will solve the problem. Thus, we track bankrupt airlines and their rivals starting three quarters prior to the actual bankruptcy filing.

Effects in post-bankruptcy periods will also be treated separately to see whether bankruptcy has a temporary or permanent effect on airlines and the industry. The significance and size of estimates on fare and capacity change in post-bankruptcy periods will show us whether the effect, if any, is persistent. Bankrupt airlines may go back to their original strategies from the time before they suffered from financial distress. On the other hand, bankrupt airlines may continue to keep their bankruptcy-period strategies even after they reemerge. There is also the possibility that the airlines become even stronger threats to rivals once they exit bankruptcy with lower debt and cost levels, engaging in aggressive strategies to win some market share lost in bankruptcy. If bankrupt airlines' behavior can change in post-bankruptcy periods, not considering those possibilities will bias the estimates on bankruptcy effects.

Second, it is noteworthy that bankruptcies often coincide with deteriorated demand conditions. The trend in demand, if it exists, matters as it may complicate the problem due to the fact that the total route capacity will decline with diminishing popularity of travelling the route and the decreasing demand may push some airlines to file for bankruptcy. The change in demand may result in a false causal relationship between bankruptcy and the total route capacity level. Dealing with the endogeneity, however, depends on our view of whether the endogeneity is local or not. Ciliberto and Schenone (2008) argued that since airlines serving routes with diminishing demand may be more likely to file for bankruptcy, the downward demand trend can complicate the estimated fare/capacity change upon bankruptcy to be biased in a negative direction. As a measure to lessen the bias, they include origin and destination specific linear time trends in their econometric models (on fare, number of available seats, or load factor). If there is a positive relationship between bankruptcy and the diminishing time trend of demand, removing the linear time trend will be appropriate. However, removing the origin and destination specific linear time trend could be problematic for several reasons.

The demand or supply shocks pushing airlines to file for bankruptcy are more likely to be economy-wide rather than market-specific. That is, airlines, especially big ones, will not be forced to file for bankruptcy just because demand is decreasing on some routes that they serve. Also, bankrupt airlines cannot choose to be bankrupt on some unprofitable routes where demand is in downward trend. Thus, it can be misleading to conclude that "bankruptcy" routes are more likely to have been suffering from diminishing demand. In addition, if the decline in demand is severe and expected to continue on some routes, then airlines will adjust their route structures by moving out of declining routes and entering into flourishing routes. That is, airlines will not stay in declining routes to file for bankruptcy.

Moreover, an important question when it comes to including the time trends is whether there actually are specific linear time trends on "bankruptcy" routes in the first place. If we look at some routes where a dominant carrier is bankrupt, it is hard to say that demand is declining on those routes as compared to other routes. If there is no specific demand time trend before any of the airlines serving the route files for bankruptcy and we include a linear time trend variable to control for the nonexistent "trend", then the estimated "trend" will be picking up all the bankruptcy-related effects, and we will have biased estimates. For example, if fare or capacity is cut even prior to bankruptcy filing and the cut continues over the bankruptcy proceedings, then the linear time trend variable will pick up this negative effect of bankruptcy on fare or capacity level, and the estimated bankruptcy effect will be biased upward. The bias from including "nonexistent" linear time trends has been explored by Wolfers (2006) on the effect of unilateral divorce laws on divorce rates. In this study, instead of including market-specific linear time trends, time-specific dummy variables will be used to take account of economic shocks common to airlines and routes, and the effects of local economic conditions will be controlled for by personal income, employment conditions, and population for origin and destination.

Third, a source of potential bias comes also from the possible pre-existing trend of growth of LCCs or decline of legacy carriers. Since the deregulation, LCCs have grown slowly but steadily. In this case, the LCC expansion in the periods surrounding rivals' bankruptcy may be a mere ratification of the pre-existing trend that would have continued even without bankruptcy. In fact, the increasing presence of LCCs may have even pushed other airlines further into bankruptcy. In that case, legacy airlines would have been experiencing reduction in operations, which might have triggered bankruptcy filings. If the pre-existing trends are not controlled for, it will lead to overestimation of bankruptcy effects on capacity setting.

We include carrier-specific linear time trends in addition to pre- and post-bankruptcy periods to account for systematic patterns in fare and capacity set by each carrier. To disentangle pre-existing growth trends from bankruptcy effects, it would be ideal to know the individual airline's growth plan and how it has been changed upon rivals' bankruptcy. Without knowledge of this, however, the best assumption would be that the pre-existing trend would have continued, were it not for rivals' bankruptcy. Including pre- and post-bankruptcy periods will control, at least partially, for the trend that may exist on a route affected by bankruptcy. In their research on the impact of workers' job losses on earnings, Jacobson, LaLonde, and Sullivan (1992) added a set of worker-specific linear time trends to take account of individual-specific rates of earnings growth. With sufficient observations for the time before being affected by bankruptcy, we can estimate the pre-existing growth trend of each carrier, if any. If we include carrier-specific linear time trends, the estimates of bankruptcy effect on rivals will capture the rivals' capacity growth (or decline) as compared to the normal periods prior to bankruptcy as well as other routes unaffected by bankruptcy.

However, caution is needed here, as in the inclusion of market-specific time trends. Without such pre-existing trends, the inclusion of individual-carrier-specific time trends may pick up the bankruptcy effects, leading to underestimation. This can be more serious for bankrupt airlines than for their rivals because a large part of change in fare and capacity in bankruptcy can be taken out as a "trend". So, we take the estimates with carrier-specific time trends as our conservative estimates for bankruptcy effects.

Fourth, different carrier groups may be affected differently by even the same demand and supply shocks. That is, relative attractiveness or relative efficiency between carrier groups may change over time, even after carrier-specific time trends are controlled for. The time-variant demand and supply conditions may lead to a decline of one carrier group but an opportunity for other carrier group. For example, a recession may be associated with a higher price-sensitivity of travelers, and hence LCCs may find it easy to attract passengers with low fares. Also, a spike in fuel costs may affect legacy airlines more seriously than LCCs. Since bankruptcies are often associated with recessions and fuel cost increases, this will lead to an overestimation of LCC expansion during legacy rivals' bankruptcies. On the other hand, a sudden decrease in demand may reduce congestion problems, which may affect the value of connected flights positively while the value of direct flights is left unaffected. In this case, since legacy airlines tend to adopt the hub-and-spoke system while LCCs tend to adopt the point-to-point system, the same negative demand shocks will affect legacy and low-cost airlines differently.

We add a set of time-specific dummy variables for each carrier group to account for the heterogeneous effects of the shocks in the same time period for different carrier groups: legacy, low-cost, and other carriers. The inclusion of year-quarter effects for each carrier group alleviates the potential bias from the changes in relative attractiveness or relative efficiency between carrier groups.

Fifth, there can be a selection bias. LCCs' route choices with limited resources upon rivals' bankruptcy may bias the estimation. It may take some time for airlines to increase the stock of airplanes and employees when they see the opportunity to expand. In this case, the airlines will instead reallocate the limited resources to more promising routes or airports in the short term. For example, if the airlines find "bankruptcy" routes profitable, then they will transfer their capacities from other routes to the "bankruptcy" routes, leading to overestimation of capacity expansion of rival airlines during rivals' bankruptcy. The reverse can be true if bankruptcy hurts rivals. Here, the self-selection issue arises not because LCCs are not identical on "bankruptcy" and "non-bankruptcy" routes but because the identical airline can redistribute the constrained capacities between "bankruptcy" and "non-bankruptcy" routes. That is, the source of bias is the combination of the dependency between routes from the mobility of capacities and the limited resources in the short-term.

However, the bias will become negligible in the long term. After all, the short-term fixed total capacity of an airline will become flexible in the long term. So, the estimated bankruptcy effects in the later period of bankruptcy will become less vulnerable to the potential bias as an airline adjusts its total capacity level. In addition, we conduct airport-level analysis as well as route-level analysis as they are complementary. Airport-level analysis will be relatively free from the bias, because the transfer of capacities between airports will be less active than that between routes.

Other time-variant confounding factors that may affect fares and capacities are included. In particular, we include the presence of LCCs, network size of a carrier, and the portion of direct flights. As we will see later, bankruptcy of a carrier serving a route may entice LCCs to enter, and the entry of LCCs has been reported to affect fare levels negatively. Also, bankrupt airlines often shrink network sizes, which may have negative impacts on fares as they cannot command premium for extensive networks. On the other hand, we add the presence of LCCs that may confound capacity change from LCC entry with bankruptcy effects as the entry of LCCs is often linked to capacity increase as fares are lowered.

5 Empirical Model

5.1 Variable Construction

We build empirical models based on the conceptual framework from the previous section. We are interested in how bankruptcy affects airlines near, during, and after bankruptcy, and how the total capacity level changes as a result. Thus, the bankruptcy-related variables are constructed in a manner so that we can capture how a bankrupt firm's and its competitors' behaviors change over time in the periods surrounding bankruptcy. Table 1.5 shows how the bankruptcy-related variables are constructed.

Table 1.5: Variable List - Bankruptcy-Related Variables

		Carrier		Route
	Event period (k)	Bankrupt airline	Rivals	"Bankruptcy" route
Pre-	$[\mathrm{T}_B-3]$			
bankruptcy	$[\mathrm{T}_B-2]$	$D[k]_{it}^m$	$W[k]_{irt}^m * Bshr[B]_{rt}^m$	$W[k]_{rt}^m * Bshr[B]_{rt}^m$
	$[\mathrm{T}_B-1]$			
During	$[\mathrm{T}_B]$			
bankruptcy	$[\mathrm{T}_B+1]$	$D[k]_{it}^m$	$W[k]_{irt}^m * Bshr[B]_{rt}^m$	$W[k]_{rt}^m * Bshr[B]_{rt}^m$
	$[\mathrm{T}_B+2\sim\mathrm{T}_{RE}]$			
Post-	$[\mathrm{T}_{RE}+1]$			
bankruptcy	$[\mathrm{T}_{RE}+2]$	$D[k]_{it}^m$	$W[k]_{irt}^m * Bshr[B]_{rt}^m$	$W[k]_{rt}^m * Bshr[B]_{rt}^m$
	$[\mathrm{T}_{RE}+3\sim]$			
Pre-exit	$[\mathrm{T}_{EX}-2]$		$W[k]_{irt}^m * Bshr[E]_{rt}^m$	$W[k]_{rt}^m * Bshr[E]_{rt}^m$
	$[\mathrm{T}_{EX}-1]$			
After-exit	$[\mathrm{T}_{EX}]$			
	$[\mathrm{T}_{EX}+1]$	(No Observations)	$W[k]_{irt}^m * Bshr[E]_{rt}^m$	$W[k]_{rt}^m * Bshr[E]_{rt}^m$
	$[\mathrm{T}_{EX}+2\sim]$			

Superscript m = *legacy* if legacy bankruptcies, *oth* if others.

T_B: Quarter of bankruptcy filing, T_{RE}: Last quarter in bankruptcy

T_{EX}: Quarter of a bankrupt airline's exit from a route

The event dates of interest include a series of quarters from three quarters prior to bankruptcy filing to post-bankruptcy periods (if a bankrupt airline reemerged) or liquidation date (if a bankrupt airline ends up being liquidated). The quarters before and after a bankrupt airline exits from a market during bankruptcy procedures will also be considered to see whether outright liquidation will help rivals improve profitability by softening competition and removing excess capacity. To our knowledge, the exit of bankrupt airlines from markets has not been covered in previous studies on airline bankruptcies. If (1) a bankrupt airline disappeared from the route that it served at some point in a year prior to bankruptcy filing and then (2) it does not show up in the data for at least for four consecutive quarters after they first disappeared, then we regard the event as a bankrupt airline's exit from the route. If liquidation of bankrupt airlines would benefit rivals by preventing bankrupt airlines from toughening competition and by eliminating excess capacity, then we expect to find the signs of improvement in rivals' profitability and reduction in the total route capacity.

We divide bankruptcy filings into two groups based on which carrier group the filing airline belongs to. If a bankrupt airline is a legacy carrier, we denote it as "legacy" bankruptcy. In other cases, the bankruptcy is denoted as "other" bankruptcy. The same set of variables will be constructed for each of the two groups, respectively. The study is more interested in legacy bankruptcies than others since, first, it informs us of the impact of large incumbent airlines' bankruptcies on their rivals and, second, the bankruptcy will affect a large number of routes so we have many observations to get more reliable estimates on bankruptcy effects as compared to other bankruptcies that involve smaller carriers so the affected markets and competitors are rather limited.

The "bankruptcy" routes and the "rivals" to bankrupt carriers can be defined in two ways depending on whether a bankrupt airline has direct flights on a route or not. A bankrupt airline can be present on a route either by operating its own direct flights or by providing connected flights or marketing tickets with other airlines through code-sharing. Our definition is based on whether a bankrupt airline is selling tickets on a route. That is, we regard an airline as being present on a route if they sell the tickets for travelling the route, even when the airline does not directly operate flights on the route. This definition emphasizes the consumer perception about whether an airline serves a route. So, we allow for the possibility that connected flights are good substitutes for direct flights. In addition, the definition based on whether to provide direct flights can involve measurement error in identifying bankruptcy effects since connected flights can be a large portion of services especially for network carriers.

We regard a route as a "bankruptcy" route if a bankrupt airline's market share is not less than 1%. The competitors selling a ticket on the "bankruptcy" route are considered "rivals" to bankrupt carriers. Since we consider the market share of bankrupt airlines (as will be explained later), the potential bankruptcy effect will depend on the degree of presence/dominance of bankrupt airlines on a route. The robustness checks using the other definition, though not reported here, are not qualitatively different from the results presented in this paper. This is because an airline is very likely to be providing direct services on a route where its market share is significant. In the airport sample, this is not an issue.

We construct bankruptcy-related dummy variables as an interaction between carrier identity (based on whether bankrupt or not and whether a legacy carrier or not) and the indicator of time intervals (pre-, during, post-bankruptcy periods, or pre- and post-exit periods). Bankruptcy indicators are a series of dummy variables for a bankrupt carrier in each event quarter k from three quarters prior to the filing through the carrier's last quarter in the sample, as listed in the column labeled "Bankrupt airlines" in Table 1.3, i.e. $k \in \{T_B - 3,\, T_B - 2,\, T_B - 1,\, T_B,\, T_B + 1,\, T_B + 2\tilde{}\, T_{RE},\, T_{RE} + 1,\, T_{RE} + 2,\, T_{RE} + 3\tilde{},\, T_{EX} - 2,$ $T_{EX} - 1,\, T_{EX},\, T_{EX} + 1,\, T_{EX} + 2\tilde{}\}$ where T_B is the quarter of bankruptcy filing, T_{RE} is the last quarter in bankruptcy before reemergence from bankruptcy if applicable, and T_{EX} is the quarter of bankrupt airlines' exit from a route. $D[k]_{it}^{\mathrm{lg}}$ is a bankrupt-carrier indicator that takes one if $t = k$ where t is calendar quarter while k is event quarter. So, $D[T_B]_{it}^{\mathrm{lg}}$, for example, takes a value of one if an airline i is a legacy carrier and it files for bankruptcy in the current quarter t. $D[T_{RE} + 1]_{it}^{oth}$ is triggered if an airline i is not a legacy carrier and it reemerged from bankruptcy in the previous quarter.

The bankruptcy indicators, $\{W[k]_{irt}^{\cdot}\}_k$, are the counterparts of bankrupt-carrier indicators for each event quarter k. $W[k]_{irt}^{\cdot}$ takes a value of one if an airline i is competing with bankrupt airlines on route r at $t = k$; that is, if there are bankrupt airlines serving route r at $t = k$. We then multiply the bankruptcy indicators for the leads and lags of bankruptcy filing dates by the average market share of bankrupt airlines for the previous year from four quarters prior to the bankrupt filing ($\equiv Bshr[B]_{rt}^{\cdot} = \frac{1}{4}\sum_{t=T_B-7}^{T_B-4} Mkt\_share_{rt}$ where T_B is the quarter of bankruptcy filing and Mkt_share_{rt} is the market share of bankrupt airlines on route r at time t). Similarly, the bankruptcy indicators before and after a bankrupt airline's exit is multiplied by the average market share of the bankrupt airline for the one year prior to four quarters before the bankrupt airline exits the market ($\equiv Bshr[E]_{rt}^{\cdot} = \frac{1}{4}\sum_{t=T_{EX}-7}^{T_{EX}-4} Mkt\_share_{rt}$ where T_{EX} is the quarter of bankrupt airline's exit from route r and Mkt_share_{rt} is the same as before).

Table 1.6: Variable List - Other Variables

	Variable	Unit	Description
Fare	Med_fare_{irt}	2000$	Median fare of irt
	$Q1\_fare_{irt}$	2000$	25% percentile fare of irt
	$Q3\_fare_{irt}$	2000$	75% percentile fare of irt
Capacity	N_seats_{irt}	1,000	# available seats of irt
	$N\_seats\_all_{rt}$	1,000	# available seats of rt
	$N\_flights\_all_{rt}$	1,000	# scheduled departures of rt
	ASM_{iat}	1,000 seat mile	Available seat miles of iat
Share	Mkt_share_{irt}	1	Share of irt in terms of passenger enplanement
	$Seat\_share_{irt}$	1	Share of irt in terms of available seats
Route	$LCCin_{rt}$		1 if LCC serves rt, 0 otherwise
Characteristics	$SWin_{rt}$		1 if Southwest serves rt, 0 otherwise
Local	Inc_origin_{rt}	10^6 2000$	Personal income in the origin city of rt
Economic	Inc_dest_{rt}	10^6 2000$	Personal income in the destination city of rt
Conditions	Pop_origin_{rt}	1,000	Population in the origin city of rt
	Pop_dest_{rt}	1,000	Population in the destination city of rt
	Emp_origin_{rt}	1,000	Total employment in the origin city of rt
	Emp_dest_{rt}	1,000	Total employment in the destination city of rt
	Inc_{at}	2000$	Personal income in the city of at
	Pop_{at}	1,000	Population in the city of at
	Emp_{at}	1,000	Total employment in the city of at
Other Carrier	$Network_{it}$	1/1000	# routes a carrier i is serving at t
Characteristics	$Direct_{irt}$	1	Percentage of direct flights in all tickets of irt

irt: a carrier i on route r at time t, iat: a carrier i at airport a at time t,
it: a carrier i at time t, rt: route r at time t, at: airport a at time t

We interact the bankruptcy indicators with the market share of a bankrupt airline to account for the possibility that bankrupt airlines' rivals' responses are different depending on the market presence of the bankrupt airline, as each market can be exposed to different degree of bankruptcy effects. For instance, even though a bankrupt airline changes capacity at the same rate in all markets, the impact of the change to competing airlines may be larger in the markets where the bankrupt airline used to be dominant. Here, the market shares from the periods before affected by bankruptcy are chosen to avoid endogeneity issues and measure the bankruptcy airlines' presence in the market when unaffected by bankruptcy. We take a one-year average since it is a more reliable measure than one-time market share, which is vulnerable to time-specific shocks. The rivals will then be divided into two groups based on whether the airline is a LCC or not.

The last column of Table 1.5 is route-level bankruptcy-related variables. Route-level analysis is intended to see the capacity change in total on bankruptcy-affected routes, as a result of financial distress, bankruptcy, reemergence, or bankrupt airlines' exit from the market. The comparison group is the set of routes where no carrier is bankrupt. Bankruptcy indicators, $\{W[k]_{rt}\}_k$, are again interacted with the average market share of bankrupt airlines serving the route for a year from three quarters prior to bankruptcy filing. Table 1.6 is the list of other variables used in the empirical analyses.

5.2 Empirical Model

We begin with fare and capacity as dependent variables as price and quantity are the main strategic tools that firms use to compete. We then see the changes in market and capacity shares of bankrupt airlines and their rivals in the periods surrounding bankruptcies. Maintaining consistency with the conceptual framework, we will use the following econometric specification:

$$\begin{aligned}\log Y_{irt} \quad = \quad & \sum_{k\in K1} D[k]_{it}^{\text{lg}}\alpha_k + \sum_{k\in K1} D[k]_{it}^{oth}\beta_k \\ & + \sum_{k\in K1\cup K2}\ \sum_{C\in\{\text{lg},oth\}} \{W[k]_{irt}^{C} * Bshr[k]_{rt}^{C} * (1-D\_lcc_i)\ \gamma_{k,C}^{nlcc} \\ & + W[k]_{irt}^{C} * Bshr[k]_{rt}^{C} * D\_lcc_i\ \gamma_{k,C}^{lcc}\} \\ & + D\_time_t \cdot \phi_1 + D\_fl,qtr_{rt}\cdot\phi_2 + X_{irt}\cdot\sigma \\ & + D_i * Trend_t\ \theta_i + \sum_{g\in G} D\_group_g * D\_time_t\cdot\omega_g + u_{irt}\end{aligned}$$

where an observation unit is carrier i on route r at time t (=1998:Q1, 1998:Q2,$\cdots$, 2008:Q2), $\log Y_{irt}$ is a dependent variable after log-transformation of variables of interest, $\log Med\_fare_{irt}$ or $\log N\_seats_{irt}$, $K1$ and $K2$ are the set of lead and lag quarters of bankruptcies and bankrupt airlines' exit, respectively ($K1 = \{T_B - 3,\ T_B - 2,\ T_B - 1,\ T_B,\ T_B + 1,\ T_B + 2\tilde{}\,T_{RE},\ T_{RE} + 1,\ T_{RE} + 2,\ T_{RE} + 3\tilde{}\}$, $K2 = \{T_{EX} - 2,\ T_{EX} - 1,\ T_{EX},\ T_{EX} + 1,\ T_{EX} + 2\tilde{}\}$), bankruptcy-related variables are as defined in the previous section with $Bshr[k] = Bshr[B]$ if $k \in K1$ and $Bshr[E]$ if $k \in K2$, D_lcc is an indicator of a LCC, X_{irt} is a set of a constant, local economic conditions e.g. log-transformed value of personal income, population, and total employment in origin and destination cities, and other control variables such as $LCCin$, $SWin$, $Network$, and $direct$ if a dependent variable is $\log Med\_fare$ and $LCCin$ and $SWin$ if a dependent variable is $\log N\_seats$,[22] D_time_t is a set of time-specific dummies for year-quarter pairs, D_fl,qtr_{rt} is a set of quarter dummies for Florida route,[23] D_i is an indicator of a carrier i ($\in I$ = set of all carriers), $Trend$ is a linear time trend (=1 if 1998$Q1$, $\cdots$, =42 if 2008$Q2$), D_i is an indicator of a carrier i ($\in I$ = set of all carriers), D_group_g is an indicator of a carrier group that has one if i belongs to group c ($\in C$ = {Legacy, LCC, Other}), and u_{irt} is the combination of a time-invariant route-carrier fixed effect (δ_{ir}) and a random shock to a carrier-route pair at time t (δ_{irt}), i.e. $u_{irt} = \delta_{ir} + \delta_{irt}$.

The strength of the data set is its panel structure, which enables us to control for time-constant individual heterogeneity. We will exploit this by employing a fixed effects model with a carrier-route pair as a panel ID. The fixed effects model is chosen to allow an individual effect to be correlated with other explanatory variables including bankruptcy-related variables. We assume that the effect of a specific carrier-route pair on fare/capacity level has a time-invariant component (δ_{ir}) and a random shock

[22] See Table 6 for the description of variables. Some control variables, such as network variables and the fraction of direct flights, seem to be related to a fare premium or discount but not to quantity level. So, those variables are dropped in the capacity equations.

[23] As for the quarter dummies for Florida route, see the paragraph on panel ID and seasonality below.

component (δ_{irt}). While the time-invariant component is captured by carrier-route dummies, the random component varies over time and thus is treated as a usual normal error term (i.e. $\delta_{irt}\,\tilde{}\,N(0, \sigma^2)$).[24]

In the basic econometric specification, the panel ID is a carrier-route pair. The airline market, however, is often characterized by seasonality (e.g. demand conditions in the first quarter differ from those in the third quarter), so a carrier-route-quarter combination may be another appropriate candidate for the panel ID. There is a trade-off between these two choices of the panel ID. If we choose a carrier-route-quarter combination over a carrier-route pair, we can better control for seasonal adjustment, but we will have much shorter data periods[25] that we can use to estimate "but for" fare/capacity level, which may lead to a biased estimation of counterfactual patterns. On the other hand, though choosing a carrier-route pair has the disadvantage that we do not control for quarterly adjustment by a carrier on a route, it allows us to have much longer data periods[26] that we can depend on to estimate counterfactual fare and capacity level but for bankruptcy events.

This study chooses a carrier-route pair as a panel ID over a carrier-route-quarter combination. We instead include quarter dummies if origin or destination airports are in Florida in addition to time specific dummy variables (from 1998:Q2 to 2008:Q2: base=1998:Q1). The time-specific dummy variables are intended to control for aggregate demand and supply shocks common to all routes and carriers or common quarterly movements in fare and capacity. Quarter dummy variables for routes originating from or destined to Florida are included because while the quarterly pattern is similar for most of routes (demand is highest in the third quarter and lowest in the first quarter), the pattern is reversed in Florida (demand is lowest in the third quarter and highest in the first quarter). The estimated coefficients for time specific dummies and Florida quarter dummies show the expected pattern.[27]

The key variables are bankruptcy-related variables. The estimates of coefficients on bankruptcy indicators, that is, a series of dummy variables for bankruptcy filing carriers, $\{D[k]\}_k$, captures the average impact of financial distress on the airlines in each quarter surrounding bankruptcy. On the other hand, the estimated coefficients on the interaction between rivals' bankruptcy and the bankrupt airlines' market share, $\{W[k] * Bshr\}_k$, show the effect of bankruptcy on rivals which are allowed to vary with different level of exposure to the bankruptcy. Bankrupt airlines' rivals fall into one of the two groups, either LCCs or non-LCCs. The difference (or similarity) in the behaviors of the two groups will help us understand how airlines have been competing (or not).

Since the dependent variable is log-transformed, the estimated coefficients are interpreted as a semi-elasticity, i.e. % change in Y, e.g. fare or capacity, in response to a unit change of RHS variable. In this model, after accounting for carrier-route individual fixed effects, the estimates for bankruptcy-related variables are interpreted as the change in dependent variable of the same airline on the same route when affected by bankruptcy.

All other empirical analyses are a modification of the basic empirical model. For the airport sample,

[24] We report Eiker-White Robust Standard Errors clustered in a panel ID to account for potential heterogeneity.

[25] Note that the panel data is composed of the yearly observations for each carrier-route-quarter combination. So, we have eleven years of observation at most.

[26] The panel data is composed of the quarterly observations for each carrier-route pair. So, we have forty two quarters of observation at most.

[27] The estimation results are similar even if we do not include the quarterly dummies for Florida or choose a carrier-route-quarter combination instead.

the same econometric specification is used except that a panel ID is now a carrier-airport pair. The empirical model for the total route capacity is as follows:

$$\begin{aligned}\log Y_{rt} &= \sum_{k\in K1\cup K2} W[k]_{rt}^{\text{lg}} * Bshr[k]_{rt}^{\text{lg}}\rho_k^{\text{lg}} + W[k]_{rt}^{oth} * Bshr[k]_{rt}^{oth}\rho_k^{oth} \\ &\quad + Z_{rt}\cdot\sigma_2 + D\_time_t\cdot\phi_2 + u_{rt}\end{aligned}$$

where an observation unit is route r at time t (=1998:Q1, 1998:Q2,$\cdots$, 2008:Q2), $\log Y_{irt}$ is a log-transformed value of the total route capacity measured by the number of available seats ($\log N\_seats\_all_{rt}$) or the number of departures ($\log N\_flights\_all_{rt}$), $W[k]_{rt}^{\cdot}$ is the indicator that bankruptcy filing airlines are serving the route as detailed in section 1.5.1, $Bshr_{rt}^{\cdot}$ and D_time_t are the same as before, Z_{rt} is the set of a constant, local economic conditions and other control variables $LCCin$, $SWin$, and, lastly, u_{rt} is the combination of a time-invariant route fixed effect (δ_r) and a random shock to a route r at time t (δ_{rt}), i.e. $u_{rt} = \delta_r + \delta_{rt}$. In this model, a panel ID is a route.

6 Results

This section reports and discusses the estimation results. Do bankrupt airlines harm rivals by increasing competitive pressure, as is often claimed? Do bankruptcies signal a depressed market uninviting to entry and expansion? We examine whether bankrupt airlines under protection harm their competitors by triggering a fare war and keeping or expanding capacities (with "unfair" cost advantages). The results do not support the accusation of potential harm of bankruptcy protection to rivals, especially to LCC rivals. The fare cuts by bankrupt airlines are not so effective that they push others to follow suit, and the slack from bankrupt airlines' capacity cut is filled by other airlines eventually, leaving the total route capacity level largely unaffected. In particular, we find that LCCs expand while bankrupt rivals reduce capacities. That is, the services that used to be provided by bankrupt airlines are now replaced by LCCs after they reduced operations. The route sample analysis shows how market competition plays out in the periods surrounding airline bankruptcies.

The airport sample analysis supplements the findings in the sense that it can inform us more about how the fixed gates and time slots at airports are redistributed between airlines and how airlines reorganize their route structures between "bankruptcy" and "non-bankruptcy" routes in the periods surrounding bankruptcy. For example, if bankrupt airlines reduce capacity but toughen price competition at the same time, rivals may choose to use the newly available facilities from the reduction to increase services on other routes unaffected by bankruptcies. From the route sample analysis, we found that LCCs expand whereas non-LCC rivals are reducing services on "bankruptcy" routes. The airport sample analysis in Section 1.6.2 shows that rivals expand while bankrupt airlines shrink. The expansion during the period is more prominent for LCCs. The results suggest that bankrupt airlines' capacity cutbacks give new openings for their rivals on average, but non-LCC competitors avoid "bankruptcy" routes and use the newly available facilities/slots to expand services on other routes, possibly because LCCs' presence is growing and so is the competitive pressure on the "bankruptcy" routes. That is, LCC expansion during rivals' bankruptcies, rather than the presence of bankrupt airlines on a route per se, may toughen the

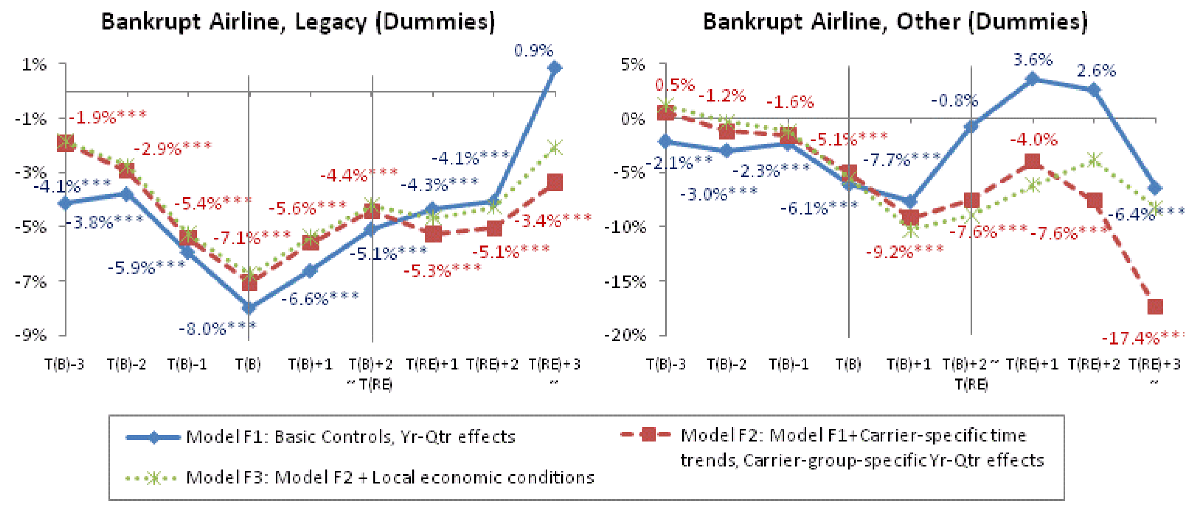

Figure 2: % Median Fare Change in the Periods Surrounding Bankruptcy, Bankrupt Airlines

competition on the "bankruptcy" routes.

6.1 Do Bankrupt Airlines Harm Rivals?

We begin with fare and capacity change as price and quantity settings are the basic tools to compete. In particular, we present the event study graphs in the periods surrounding airline bankruptcies.

Figure 2[28] reports the estimation results on median fare.[29] Model F1 includes *LCCin*, *SWin*, *Network*, *Direct*, and the dummy variables for each pair of year and quarter (i.e. time-specific effects) for controls. Model F2 adds carrier-specific linear time trends and year-quarter dummy variables for each carrier group (Legacy, LCC, or Other) to account for heterogeneity between carriers. We consider Model F2 as our conservative and main model. Model F3 includes local economic conditions: personal income, employment, and population in origin and destination cities. The samples used in Models F1, F2 and F3 do not match exactly (see the sample size N) due mostly to the lack of data on recent local economic conditions. In particular, Model F3 does not cover non-MSAs and the quarters in 2008. Also, the analysis with Model F3 does not cover the second bankruptcies of Aloha and ATA Airlines (which ended in liquidation) and the bankruptcy of Frontier airline. Considering that these bankrupt events compose a large portion of samples for "other" bankruptcies, the differences in estimates between Models F2 and F3 may be caused by the difference in bankruptcy events covered in the analysis.

$T(B)$ is the quarter of bankruptcy filing, $T(RE)$ is the quarter of reemergence from bankruptcy, that is, the last quarter in bankruptcy, and $T(EX)$ is the quarter of exit by a bankrupt airline from a route. For bankrupt airlines, the fare change is measured by dummy variables indicating each period surrounding bankruptcy, which would capture an average change. The estimated coefficients are labeled and marked with * if significant at 10%, ** if significant at 5%, and *** if significant at 1%. Throughout this paper,

[28]Model F1: N=182,437, R^2=0.1129, Model F2: N=182,437, R^2=0.1528, Model F3: N=169,430, R^2=0.1564
T(B)=Quarter of bankruptcy filing, T(RE)=Last quarter in bankruptcy
* if significant at 10%, ** if significant at 5%, *** if significant at 1%

[29]The table of regression result for Model F2 is in the Appendix, Table A1.

we do not label estimates for the model with local conditions because the estimates are not dramatically different from those of model without those local conditions in most cases.

The first graph shows the fare change for bankrupt legacy carriers. Fares decrease about 3-5% even prior to bankruptcy filing. Once a legacy airline files for bankruptcy, the median fare is even lower, over 7% in the first two quarters in bankruptcy and about 4.4% later, as compared to normal periods before they are at risk of bankruptcy. These fare cuts are not negligible even as compared to average quarterly fare change (about 3%). The bankrupt airlines' fares show a modest upward trend after the early periods in bankruptcy, though it does not return to the original level. The second graph shows the fare change for other non-legacy bankrupt airlines (low-cost or regional airlines). Although it shows a sign of fare decrease, the decrease is not statistically significant in Models F2 and F3. The median fare is significantly lower in the quarter of bankruptcy than normal and the size of fare decrease is even larger during bankruptcy.

The bankrupt airlines' fare cuts appear to be initiated by financial distress prior to an actual bankrupt filing, and the sizes of fare cuts become larger in bankruptcy. Likely explanations for the fare cuts prior to the filing are that the cuts are desperate moves of the near-bankruptcy airlines to avoid bankruptcy filing and liquidation or that the near-bankruptcy airlines that think an immediate liquidation is highly unlikely expect the substantial cost reduction under Chapter 11 and cut fares in advance. Bankrupt airlines tend to maintain low fares even after reemergence. Unlike the previous findings reported by Borenstein and Rose (1995), the fare cuts do not quickly dissipate after bankruptcy filing. Therefore, we cannot conclude that financial distress explains all the fare cuts by bankrupt airlines and bankruptcy filing itself does not have an impact on the fare cuts. The deep discount upon bankruptcy filing indicates that bankruptcy filing itself has some effect on fares; consumers may discount bankrupt airlines and/or their rivals may cut fares to hurt the weakened airlines in bankruptcy and even chase them out of a market.

For the competitors to bankrupt airlines, we use the interaction between bankrupt airlines' presence (average market share for four quarters before affected by bankruptcy or that before affected by bankrupt airlines' exit: $Bshr$ as defined in Section 1.5.1) and the bankruptcy indicator as detailed in Section 1.5.1. The bankrupt airlines' normal market shares are considered to allow for different levels of the effects depending on different degrees of exposure to rivals' bankruptcy. The estimates labeled in the graphs are the coefficient estimates from regression and average market share of bankrupt airlines on a route in each case ("legacy" or "other" bankruptcy, bankrupt legacy airlines' or bankrupt non-legacy airlines' exit). The "bankrupt" share is about 25% on average on "bankruptcy" routes for both "legacy" and "other" bankruptcies, and its distribution is right-skewed. The average "bankrupt" share on routes where bankrupt airlines exit is about 5% for "legacy" bankruptcies and it is about 10% for "other" bankruptcies. Thus, the graph shows the effect of exposure to rivals' bankruptcy measured at average "bankrupt" share (i.e. $Bshr$). For example, the estimated change in fares of bankrupt airlines' rivals when bankrupt airlines' normal market share is 25% is the estimated coefficient multiplied by 0.25. Figure **??** reports the estimation results for "legacy" bankruptcies, and Figure **??** shows the results for "other" bankruptcies.

Prices are strategic complements. So, the fare cuts by bankrupt airlines may push others to follow suit, as is often claimed. In case of "legacy" bankruptcy, non-LCC rivals tend to follow the bankrupt airlines' fare cuts in the previous quarter of bankruptcy filing and the first two quarters of bankruptcy

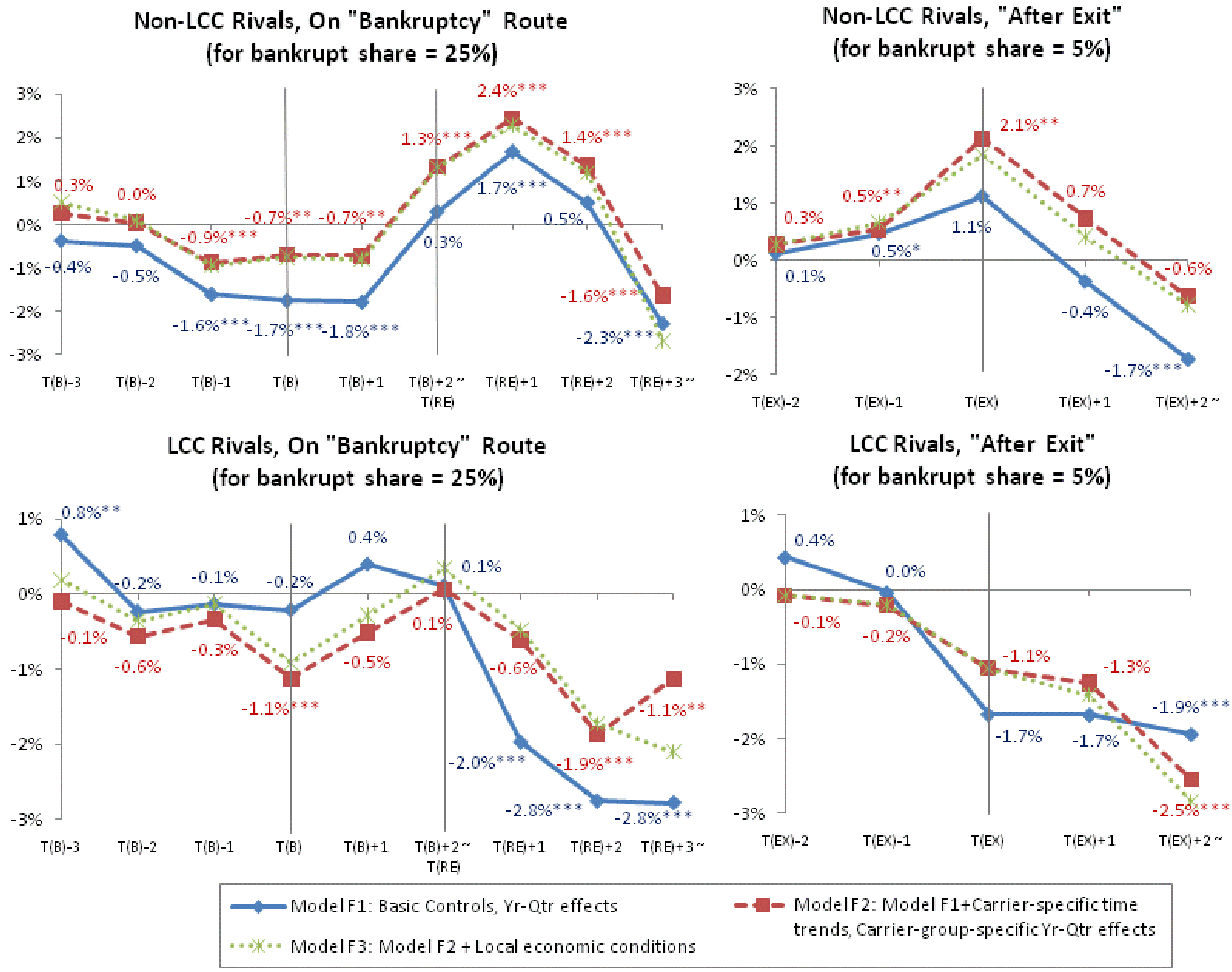

Figure 3: % Median Fare Change in the Periods Surrounding "Legacy" Bankruptcy, Rivals

while LCC rivals' median fares are cut only in the quarter of bankruptcy filing but the fare is unaffected in the rest of the periods of the bankruptcy. Even the fare cuts by rivals upon "legacy" bankruptcy are not significant as compared to those of bankrupt airlines. Thus, bankrupt airlines' fare cuts do not appear to put competitive pressure on their rivals to match the substantial fare cuts. In the post-bankruptcy periods after reemergence, however, bankrupt legacy airlines keep lower fares, and the fares eventually decrease for both LCC and non-LCC rivals. The lowered fare levels for all airlines in the long term may indicate the toughened competition after, rather than during, bankruptcy.

If an outright, immediate liquidation of a large carrier would have improved profitability for remaining airlines, as is often claimed, we should expect to see fare increases after a bankrupt airline withdraws all the services from a route ("After Exit"). The results do not support this view.

The changes in rivals' fares in the periods surrounding legacy airlines' bankruptcy are mostly not statistically significant. The fares of non-LCC rivals have increased until the quarter of bankrupt airline's exit ($T(EX)$), but they quickly decreased after. The median fares of LCC rivals, on the other hand, show sign of decrease after a bankrupt carrier exits a route. As we will see in the capacity change analysis, this may be because LCCs have expanded after a bankrupt airline is gone and competitive pressure has

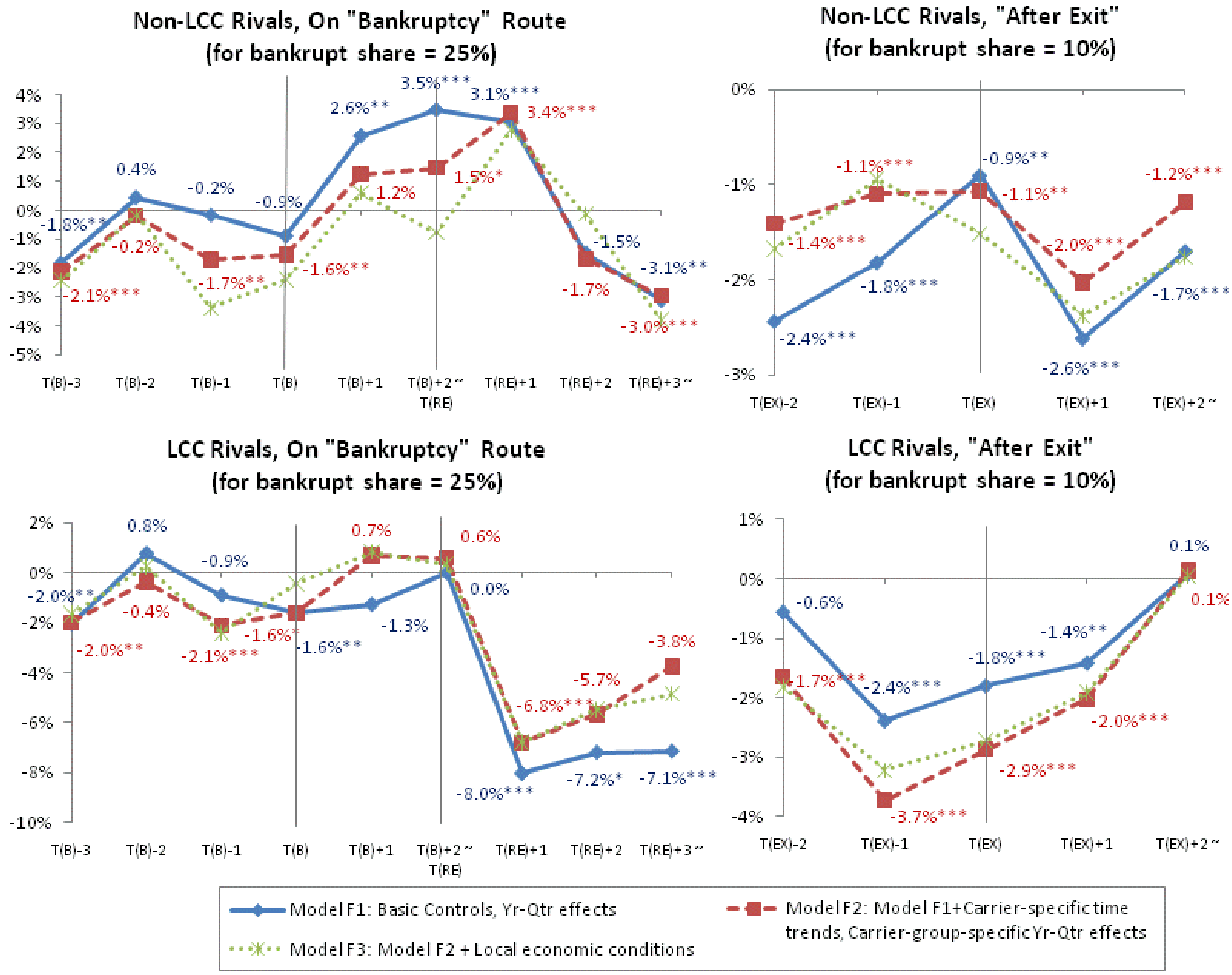

Figure 4: % Median Fare Change in the Periods Surrounding "Other" Bankruptcy, Rivals

increased with it, as seen on the “bankruptcy” routes.

In addition, it is noteworthy that the Trans World Airlines (TW) is acquired by American Airlines (AA), and hence its exit from a route may indicate the transfer of its assets to American Airlines. So, it is possible that the merged airline tried to raise fares but the fare increase did not last long due to the increased competitive pressure from LCC growth on the route.

In sum, while legacy airlines engage in significant fare cuts in bankruptcy, their rivals’ fares do not change significantly during the same period, which indicates that the bankrupt airlines’ fare cuts are not as effective as often argued. Rather, their fares decreased in the post-bankruptcy periods. This result suggests that competition may have toughened as LCCs expanded during legacy rivals’ bankruptcies. It is also likely that those bankrupt legacy carriers managed to cut cost levels under Chapter 11 and reemerged as more efficient and stronger competitors.

In case of other (non-legacy) bankruptcies, competitors seem to set lower fares in the pre-bankruptcy periods and the quarter of bankruptcy filing, but not in the rest of the periods of bankruptcy. The pattern suggests the possibility that rivals of bankrupt airlines, but not the bankrupt airlines, themselves, may have put price competitive pressures, as an attempt to push the weakened airlines under financial distress to bankruptcy, and hopefully even to liquidation. During bankruptcy after bankruptcy filing, the fare changes are negligible for both LCC and non-LCC rivals. In the post-bankruptcy periods, however, the rivals seem to keep their fares lower than usual in the long term. The fares of LCC rivals are significantly lower than normal right before a bankrupt airline exits a market but they rise after the exit. The fares of non-LCC rivals are higher than usual near and right after reemergence, but the fares decrease in the later periods.

The estimated coefficients on other variables seem to make sense. First of all, in the fare equation Model F1, when LCCs are present on a route ($LCCin = 1$), the median fares are lower by 9.1% (Est.=-0.0905, SE=0.0065). If the low-cost airline is Southwest ($SWin = 1$), the fare is even lower by 9.3% (Est.=-0.0932, SE=0.0086), so the total fare cuts under the presence of Southwest are substantial, about 18.4%. The number of routes a carrier is serving ($Network$) is positively correlated with median fare level but the impact of network size does not appear to be large in this model; the fare is higher by 1.9% with 1000 more routes (Est.=0.0185, SE=0.0283). The portion of direct flights ($Direct$) is positively related to median fare level: 3% higher with 1 percentage point more direct flights (Est.=0.0299, SE=0.0116). The results from Model F2 are mostly the same for those variables except for $Network$ (Est.=-0.0886, SE=0.0064 for $LCCin$, Est.=-0.0820, SE=0.0085 for $SWin$, Est.=-0.0226, and Est.=0.0348, SE=0.0113 for $Direct$). The estimated effect of network size increases significantly to 9.3% (Est.=0.0931, SE=0.0287). In the results from Model F3, the log-transformed values of employment level and personal income in the origin and destination cities are statistically significant with positive effects on median fares while the estimates on population variables are insignificant (Est.=0.1643, SE=0.0903 for $\log Emp\_origin$, Est.=0.1572, SE=0.0880 for $\log Emp\_dest$, Est.=-0.1132 SE=0.0525 for $\log Inc\_origin$, Est.=-0.1086, SE=0.0499 for $\log Inc\_dest$, Est.=0.0361, SE=0.0834 for $\log Pop\_origin$, and Est.=0.0270, SE=0.0832 for $\log Pop\_dest$).

The same analysis on the 25^{th} percentile and 75^{th} percentile fares, though not reported here, shows a similar pattern. One thing to note is that, as compared to median fares, 25^{th} percentile fares change less while 75^{th} percentile fares change more. In particular, 25^{th} percentile fares set by LCCs change little during legacy rivals' bankruptcies whereas 75^{th} percentile fares of bankrupt legacy airlines decrease substantially and those of their LCC rivals decrease in the first two quarters of those legacy rivals' bankruptcies. The results suggest that bankruptcy has a larger impact on the upper percentiles of fares than on the lower percentiles of fares.

Now, let's take a look at the other side of competition: capacity setting. The results on fares raise questions on capacities. First, are bankrupt airlines keeping or expanding capacities to make up the low fares with volume? Second, are their rivals reducing operations to support the fare level? The next three graphs, Figures 5-6 show bankrupt airlines' and their non-LCC and LCC rivals' average capacity levels as compared to counterfactuals in each period surrounding bankruptcies, respectively.[30]

Throughout the paper, capacity is measured by the number of available seats unless otherwise stated.[31]

[30] The table of regression results for Model C2 is in the Appendix, Table A2.

[31] Capacity can be measured in the number of available seats, available seat miles (ASM), or the number of scheduled departures (i.e. number of flights). The most common measure of capacity in the industry is ASM. In the route sample analyses, since the distance between origin and destination of a route does not change over time, the number of available seats and ASM are basically the same measure. In the airport sample analyses, both of the measures are considered and the

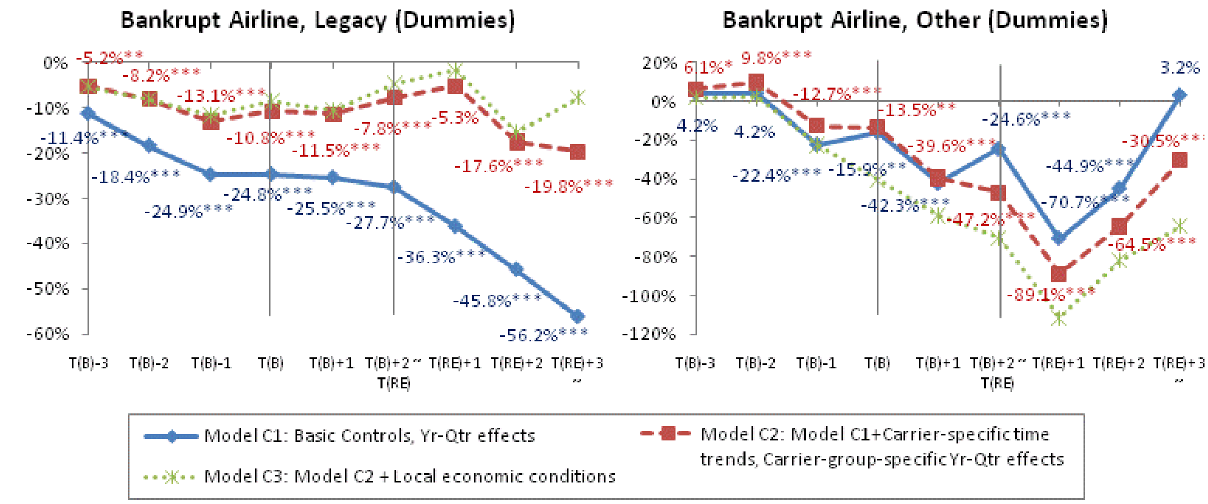

Figure 5: % Capacity Change in the Periods Surrounding Bankruptcy, Bankrupt Airlines

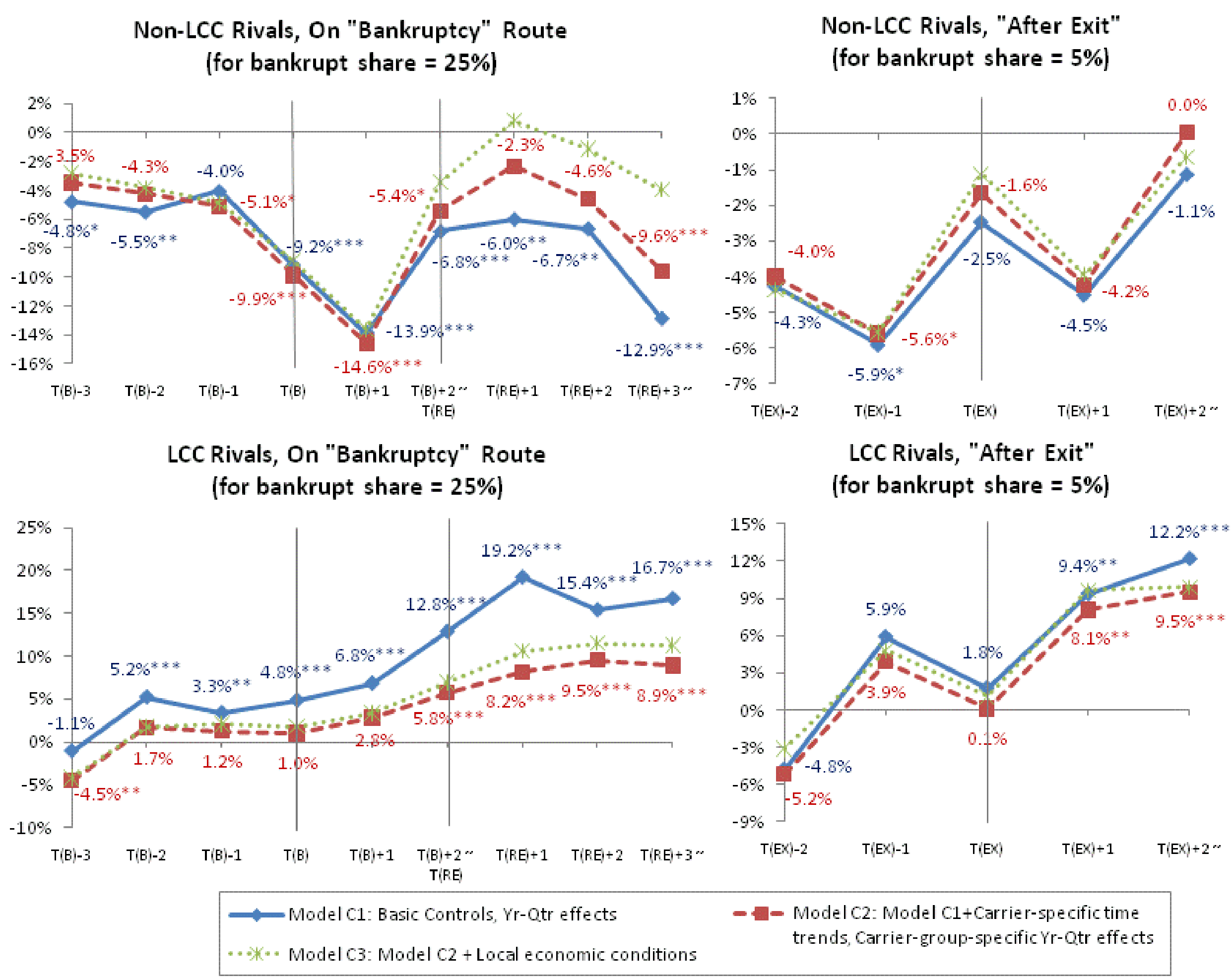

Figure 6: % Capacity Change in the Periods Surrounding "Legacy" Bankruptcy, Rivals

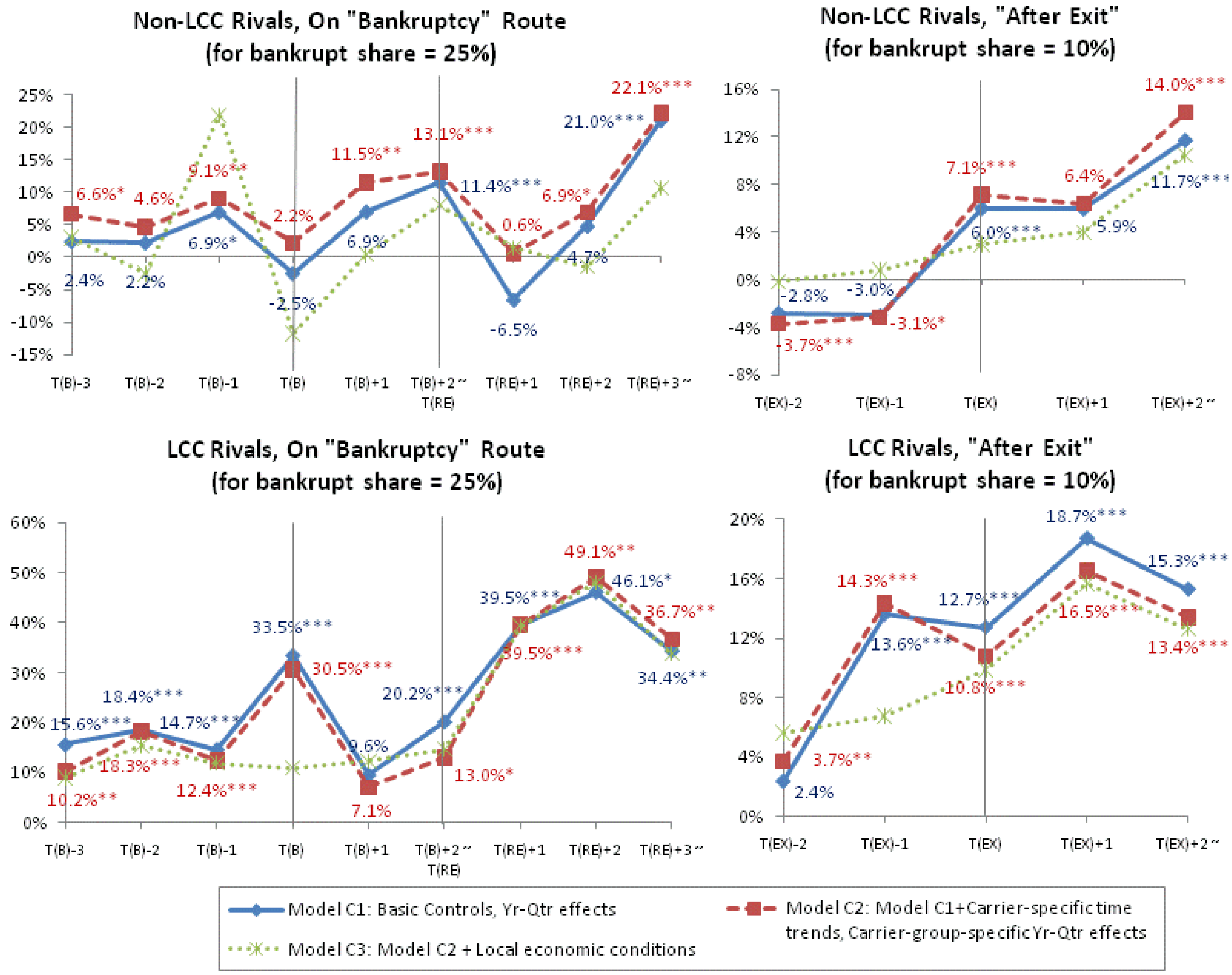

Figure 7: % Capacity Change in the Periods Surrounding "Other" Bankruptcy, Rivals

The capacity change is estimated by three empirical models with different RHS variables. Model C1 is the basic empirical model including year-quarter dummies and $LCCin$ and $SWin$ for controls. Model C2 includes carrier-specific linear time trends as an attempt to control for potential pre-existing growth patterns and carrier-group-specific year-quarter dummy variables to account for changes in relative attractiveness and efficiency over time. The model is intended to control for time-variant heterogeneity between carriers.[32] Lastly, we add local economic conditions in Model C3. The estimated coefficients are labeled for Model C1 and C2. The statistical significance is marked next to the estimates as in the fare graphs.

The estimation results shown in Figure 5[33] suggest that bankrupt airlines reduce their operations

results are similar. So, we report only the results on ASM for the airport sample.

[32] We need to be careful in interpreting the results from Model C2 since the carrier-specific time trends may be capturing a large portion of the changes spurred by bankruptcies. One thing to see would be whether the difference between estimated coefficients from the two models is large at the beginning of the event periods (i.e. three quarters prior to bankruptcy filing in this study). If the difference is negligible, it is likely to indicate that pre-existing trends do not exist and the coefficients on carrier-specific time trends actually pick up bankruptcy effects.

[33] Model C1: N=82,333, R^2=0.0662, Model C2: N=82,333, R^2=0.0828, Model C3: N=75,407, R^2=0.0882
T(B)=Quarter of bankruptcy filing, T(RE)=Last quarter in bankruptcy

substantially as they near bankruptcy. This capacity reduction continues even in the post-bankruptcy periods, so the capacity level is cut by about 20% for legacy bankrupt airlines and by about 40% for other bankrupt airlines in the long term (in our conservative model, Model C2). Adding local conditions to Model C2 (i.e. Model C3) does not change the result much.

During the same period, how do rivals to bankrupt airlines set capacities? Figure 6 presents capacity changes for rivals in the periods surrounding legacy carriers' bankruptcy. Interestingly, the estimation results show that LCCs tend to expand whereas non-LCCs rather shrink during rivals' bankruptcies. In particular, non-LCC rivals' capacities show a steep decrease while a legacy carrier is in bankruptcy, by around 15% at largest when measured at average "bankrupt" share (=25%). The capacities appear to bounce back with rivals' reemergence but go down again in the long term.

On the other hand, LCC rivals show an upward trend in capacity evel while a legacy carrier is bankrupt in all models. After controlling for heterogeneity between carriers, the estimated coefficient on the period three quarters prior to a legacy carrier's bankruptcy becomes negative and significant. This may indicate that including carrier-specific time trends are over-capturing the potential growth trend. In other words, this may suggest that the growth of LCCs had been rather slower on "bankruptcy" routes than on other unaffected routes before legacy carriers' bankruptcy and then accelerated as the legacy rivals near bankruptcy. Thus, the LCC growth spurred by legacy rivals' bankruptcies would be larger than the estimates from Model C2. We can see that most of the LCC growth from pre-bankruptcy periods occurred during, rather than after, a rival's bankruptcy.

A bankrupt airline's capacity cut can be interpreted as an effort to reduce total expenses quickly and to regain a proper liquidity level. This effort would not stop at reducing services. Bankrupt airlines also drop relatively unprofitable routes as a means to reduce capacity and hence cut costs. The "After Exit" graphs show the responses of remaining airlines to bankrupt airlines' exit from a market. Throughout the periods surrounding the exit, non-LCC rivals seem to maintain fewer seats than normal but show signs of increase though the estimates are not statistically significant. In the long term, the capacity level does not appear to be different from the normal level. During the same period, LCC rivals increase capacities, which leads to about 10% more seats than usual in the long term if the bankrupt airline used to hold 5% market share (which is the average "bankrupt" share on routes where a bankrupt legacy carrier exited). Though not reported here, the results do not change when we use the number of scheduled departures instead of the number of available seats as a measure of capacity.

Figure 7 reports the capacity changes for rivals in the periods surrounding "other (non-legacy)" bankruptcy. Unlike in "legacy" bankruptcy, the growth pattern is not much different between LCC and non-LCC rivals. Throughout the periods, both LCC and non-LCC show signs of increase in capacity. The results seem to be consistent with the fact that the bankrupt airlines have been significant competitors, although they ended up in bankruptcy, and their weakened market presence gives all other rivals the opportunities to expand.

In the regression results from Model C1, the presence of a LCC ($LCCin$=1) does not have a significant relationship with capacity level, whereas Southwest is positively and significantly related to capacity levels (Est.=0.0175, SE=0.0210 for $LCCin$, and Est.=0.0669, SE=0.0327 for $SWin$). After controlling for

* if significant at 10%, ** if significant at 5%, and *** if significant at 1%

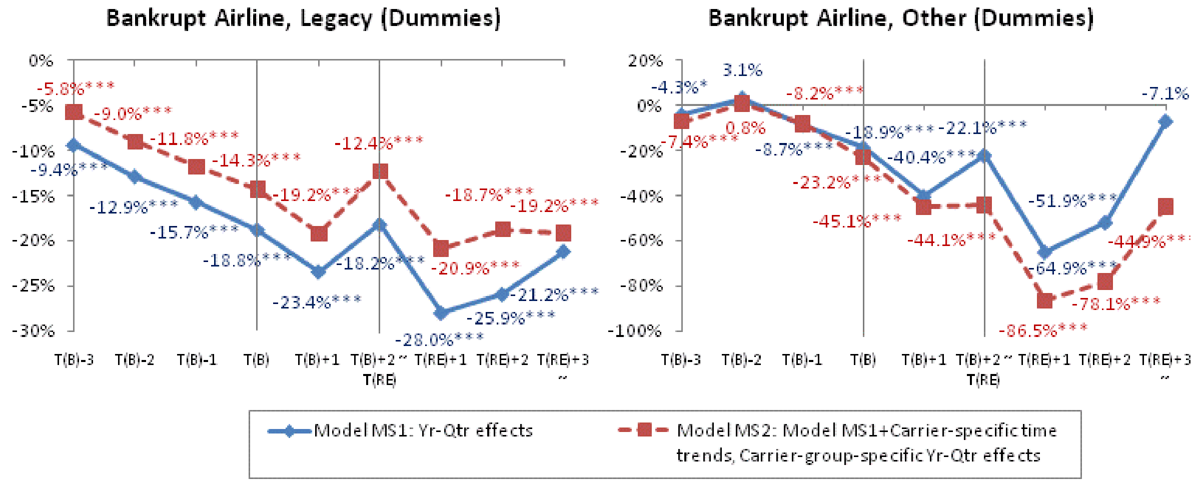

Figure 8: % Market Share Change in the Periods Surrounding Bankruptcy, Bankrupt Airlines

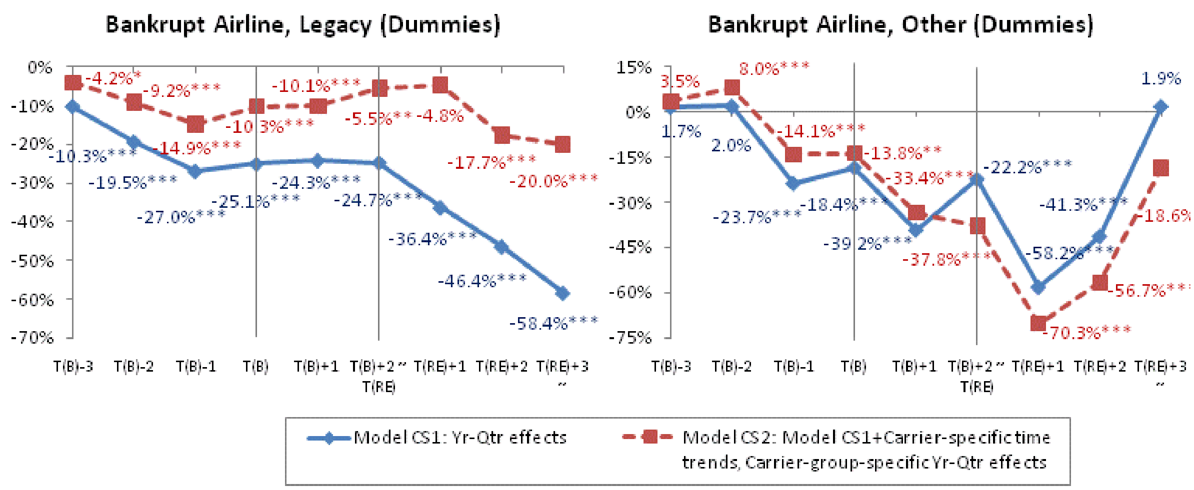

Figure 9: % Capacity Share Change in the Periods Surrounding Bankruptcy, Bankrupt Airlines

time-variant heterogeneity between carriers (Model C2), the estimated coefficients are higher and more significant (Est.=0.0293, SE=0.0223 for $LCCin$, and Est.=0.0794, SE=0.0349 for $SWin$). Including local economic conditions does not change the estimates on the two variables. The log-transformed values of employment level in the destination city and personal income in the origin city are positive and significant at 1% and 5%, respectively (Est.=0.5618. SE=0.3996 for $\log Emp\_origin$, Est.=1.1403, SE=0.4215 for $\log Emp\_dest$, Est.=0.5360, SE=0.2267 for $\log Inc\_origin$, Est.=0.2745, SE=0.2433 for $\log Inc\_dest$, Est.=0.1194, SE=0.3745 for $\log Pop\_origin$, and Est.=-0.2483, SE=0.3894 for $\log Pop\_dest$).

How would market and capacity shares change in the periods surrounding bankruptcy? Figures 8-13 present the estimated change in the two measures of market presence in those periods. Market share is defined as a carrier's share on a route in terms of passenger enplanements whereas capacity share is measured as a carrier's share in terms of the number of seats available.

Models MS1 and CS1 do not account for time-variant heterogeneity between carriers as they includes only year-quarter dummy variables to control for aggregate shocks common to all carriers. Meanwhile, Models MS2 and CS2 include carrier-specific time trends and year-quarter dummy variables for each carrier group.

The results are consistent with the findings in the analysis on capacity changes that LCC rivals actively expand their presence while bankrupt airlines, especially legacy carriers, shrink their operations. Market and capacity shares move together, and the movements over the course of bankruptcy are mostly consistent with the capacity changes presented before. In particular, Figures 8[34] and 9[35] show that bankrupt legacy carriers experience significant declines in both market share and capacity share on routes as they near bankruptcy. We have seen that a large portion of capacity reductions by bankrupt airlines occurs in the pre-bankruptcy periods, which is consistent with the patterns of market and capacity share changes. While the market and capacity shares of bankrupt legacy carriers are even lower after reemergence than during bankruptcy, those of bankrupt non-legacy carriers record the lowest point right after reemergence and appear to regain some of the shares, although not all the way up to the normal levels.

The loss in market and capacity shares of bankrupt airlines is significant. To whom are the bankrupt airlines losing their market and capacity shares?

Figures 10 and 11 show the changes in market and capacity shares for bankrupt legacy airlines' rivals. Non-LCC rivals tend to have the same or lower market and capacity shares in the periods of interest as compared to normal times whereas LCC rivals have won both market and capacity shares on "bankruptcy" routes throughout the periods. The growth pattern of LCCs is even more prominent if we look at capacity shares.

Once a bankrupt airline exits from a route, other airlines, especially LCCs, seem to win market share at least in the later periods. Non-LCC rivals' market share shows a jump upon bankruptcy airlines' exit. Part of the jump is likely to be caused by the acquisition of TWA by American Airlines. The capacity and market shares of LCC rivals tend to be higher in pre- and post- exit of bankrupt airlines than normal.

[34] Model MS1: N=182,437, R^2=0.0502, Model MS2: N=182,437, R^2=0.0862, Model MS3: N=169,430, R^2=0.0902
T(B)=Quarter of bankruptcy filing, T(RE)=Last quarter in bankruptcy
* if significant at 10%, ** if significant at 5%, and *** if significant at 1%

[35] Model CS1: N=82,333, R^2=0.0556, Model CS2: N=82,333, R^2=0.0741, Model CS3: N=75,407, R^2=0.0743
T(B)=Quarter of bankruptcy filing, T(RE)=Last quarter in bankruptcy
* if significant at 10%, ** if significant at 5%, and *** if significant at 1%

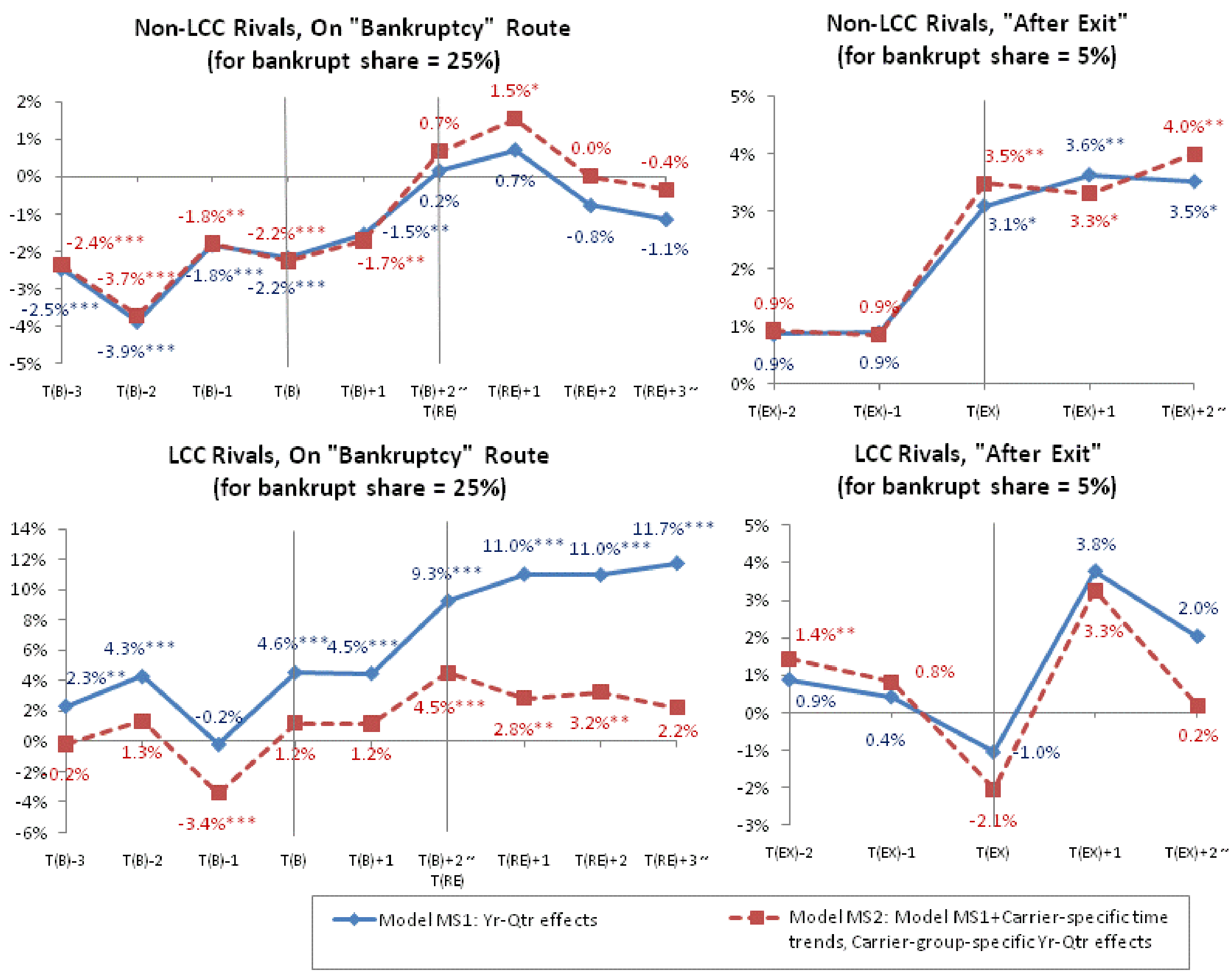

Figure 10: % Market Share Change in the Periods Surrounding "Legacy" Bankruptcy, Rivals

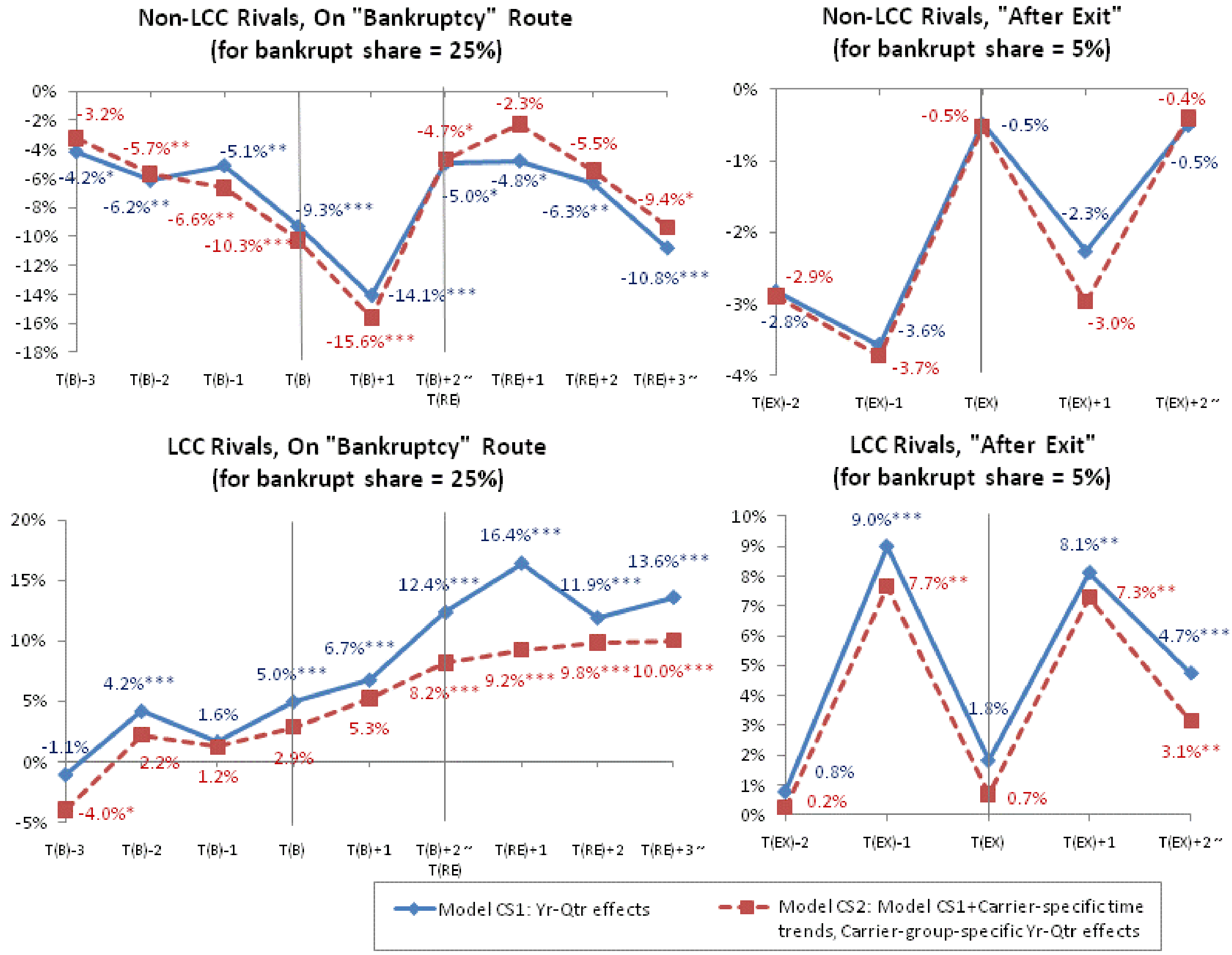

Figure 11: % Capacity Share Change in the Periods Surrounding "Legacy" Bankruptcy, Rivals\

Therefore, bankruptcy of legacy carriers appears to present new growth opportunities, at least for their efficient, LCC rivals.

Figures 12 and 13 report the estimation results for "other" bankruptcies. In this case, both non-LCC and LCC rivals tend to increase in market and capacity shares as in the analysis of capacity changes, although the patterns are not as robust as in the analysis of "legacy" bankruptcies.

So far, we have seen carrier-level changes in fare, capacity, and market/capacity shares in the periods surrounding bankruptcy. The main findings are that bankrupt airlines cut fares as well as capacities, and LCC rivals do not match the fare cuts and expand capacities and market presence. In addition, this pattern is even more prominent when a bankrupt airline is a legacy carrier and its market share used to be higher on a route in normal times before affected by bankruptcy. Thus, bankrupt airlines' fare cuts are not effective enough to hurt their rivals. Moreover, bankrupt airlines do reduce capacities and their disappearance from a route does not appear to help others to increase profitability in the case of "legacy" bankruptcies.

The rivals' fare cuts in the post-bankruptcy periods suggest that, though bankrupt carriers may have triggered fare cuts in the beginning, it could be their capacity cuts that increase price competition by

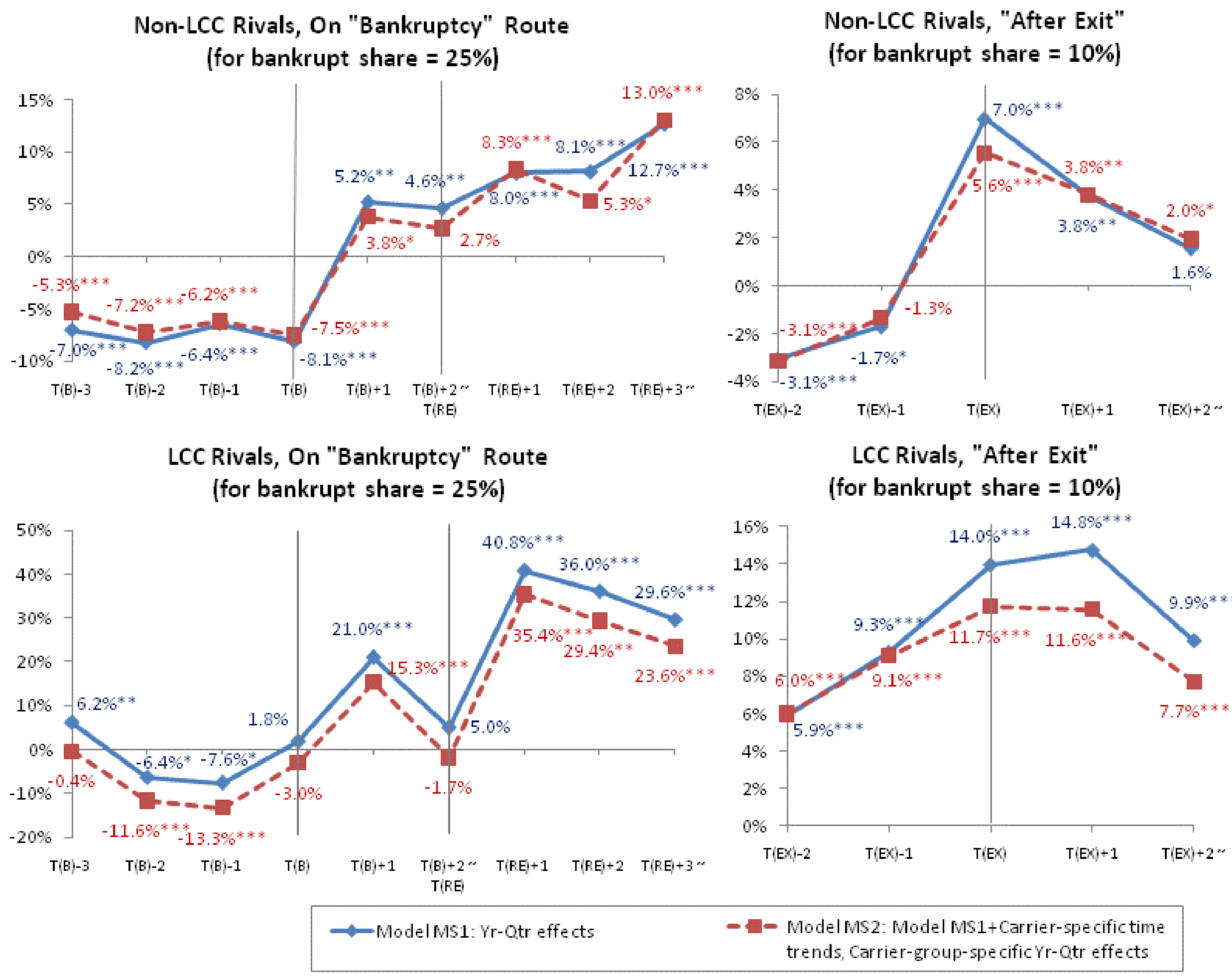

Figure 12: % Market Share Change in the Periods Surrounding "Other" Bankruptcy, Rivals

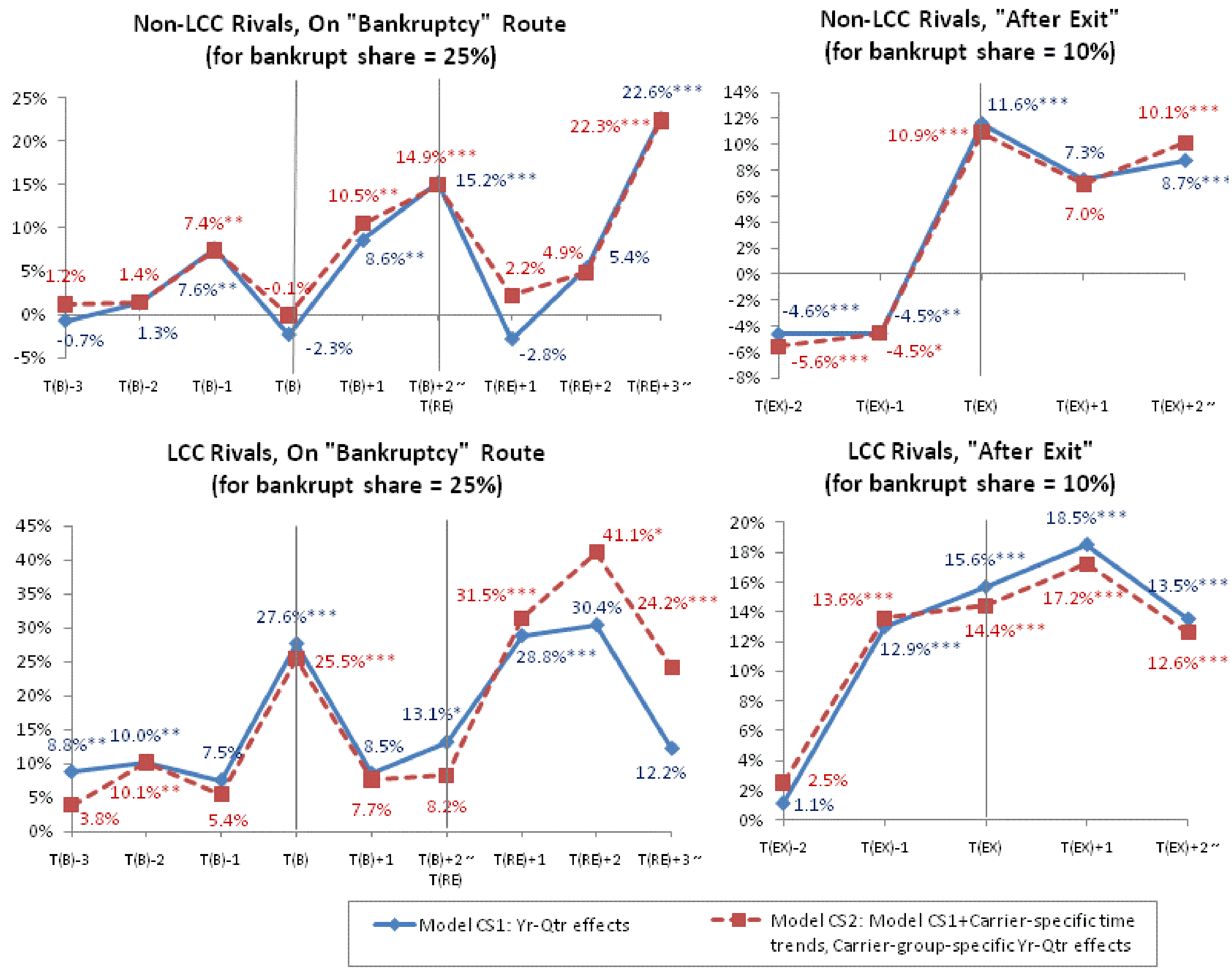

Figure 13: % Capacity Share Change in the Periods Surrounding "Other" Bankruptcy, Rivals

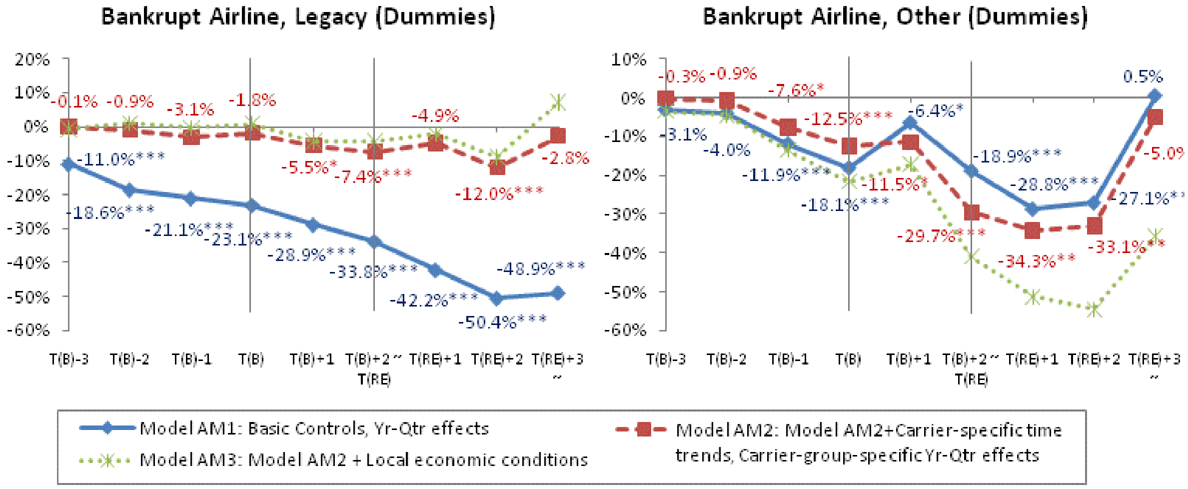

Figure 14: % Capacity Change at Airport in the Periods Surrounding Bankruptcy, Bankrupt Airlines: Capacity Measured by Available Seat Miles (ASM)

allowing LCCs to expand. The LCC expansion raises competitive pressure, not only for legacy carriers but also for LCCs themselves, as average competitors are stronger. In sum, bankrupt airlines per se do not seem to harm rivals' profitability. Instead, the increasing exposure to LCCs can be more significant. In particular, cost-efficient airlines reap the benefits from bankrupt airlines' capacity cutbacks and expand, leading to even fiercer competition. In other words, the industry transition in favor of more efficient and stronger players may have been facilitated by bankruptcies and the capacity cuts associated with them. The LCCs benefit today as bankrupt rivals shrink, but the competition appears to get tougher as the rivals become stronger.

6.2 Using the Airport Sample

This is a supplementary section that confirms the findings in the previous section and highlights how capacities are redistributed between airlines during bankruptcy and how airlines reorganize their route structures between "bankruptcy" and "non-bankruptcy" routes, given fixed facilities and slots of airport. Airport is rather a set of fixed resources than a market. In this sense, while the route sample analysis shows how market competition plays out in the periods surrounding airline bankruptcies, the airport sample analysis focuses how the resources are redistributed between airlines. Bankrupt airlines' capacity cutbacks may provide room for other airlines to expand. The growth of LCCs at airports spurred by bankruptcy of rivals that have been operating at the airport may indicate the existence of barriers from fixed facilities and slots.

For the airport sample, the same empirical models will be used as for the route sample, except we replace route with airport and dependent variables will be the capacity measured by available seat miles (which is the most common measure of airline capacity) and airport market share.

First, Figures 14[36]-16 are the event study graphs from estimation results for airline capacity changes

[36] Model AC1: N=59,359, R^2=0.0807, Model AC2: N=59,359, R^2=0.1750, Model AC3: N=51,950 R^2=0.1987
T(B)=Quarter of bankruptcy filing, T(RE)=Last quarter in bankruptcy

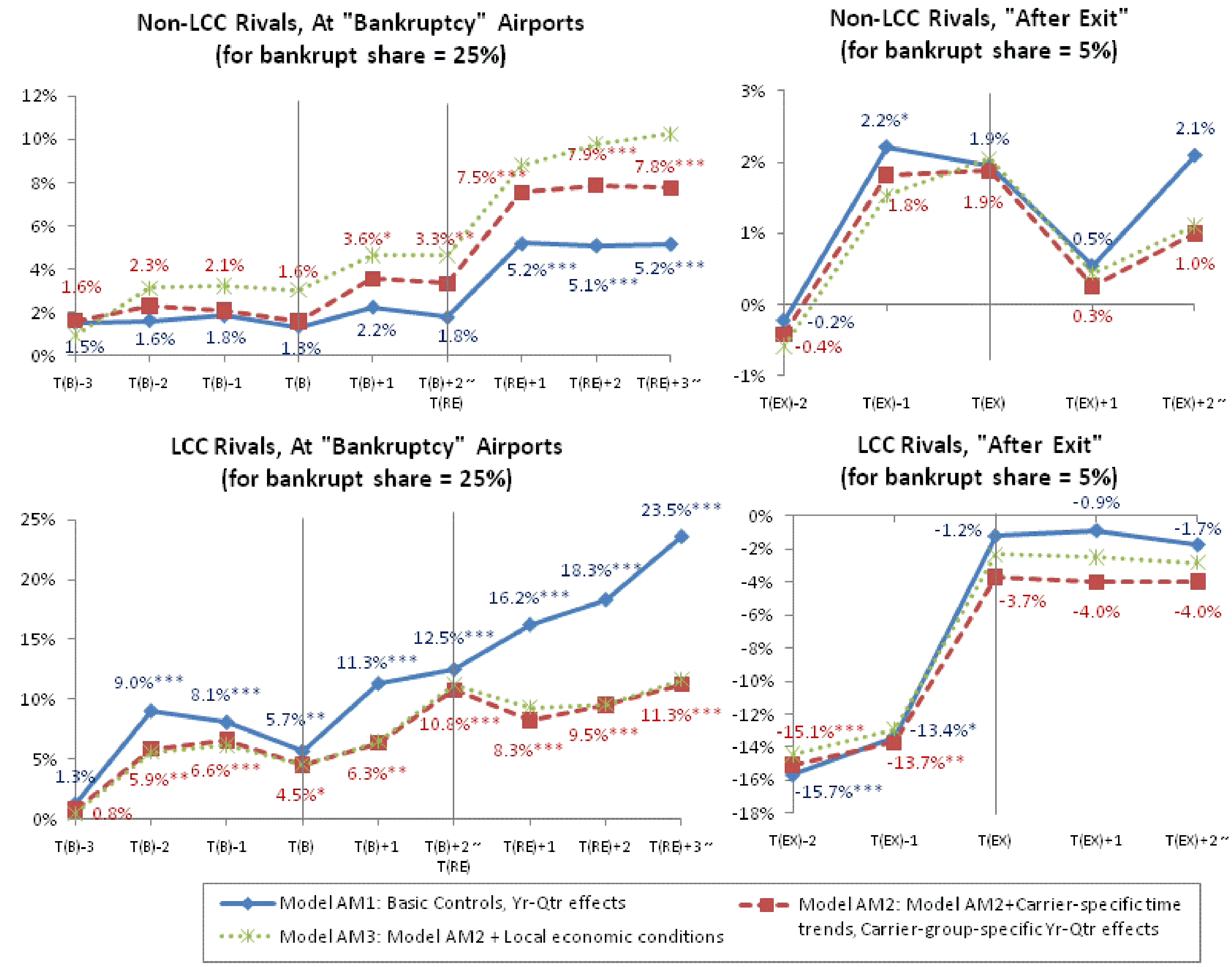

Figure 15: % Capacity Change at Airport in the Periods Surrounding "Legacy" Bankruptcy, Rivals: Capacity Measured by Available Seat Miles (ASM)

at “bankruptcy” airports.[37] Models AM1-AM3 are comparable to Models C1-C3 used for the estimation of airline capacity changes on “bankruptcy” routes. Although not reported here, the analyses using other measures of capacity such as the number of available seats or the number of scheduled flights led to similar conclusions.

As in the route sample analysis, the estimation result using the airport sample shows the pattern that LCCs expand while bankrupt airlines shrink. The difference is that non-LCC rivals also show signs of increase in capacity during the same period, although the LCC expansion is greater. Considering that non-LCC rivals tend to reduce capacity while a legacy carrier is in bankruptcy, the result suggests that non-LCC rivals avoid “bankruptcy” *routes* but pick up the resources available at “bankruptcy” *airports* after bankrupt airlines reduced operations.

A likely explanation for this finding is that the presence of bankrupt airlines on a route is associated with deteriorated profitability of serving the route for non-LCC rivals due to the rising presence of LCCs

* if significant at 10%, ** if significant at 5%, and *** if significant at 1%

[37] The table of regression result for Model AM2 is in the Appendix, Table A3.

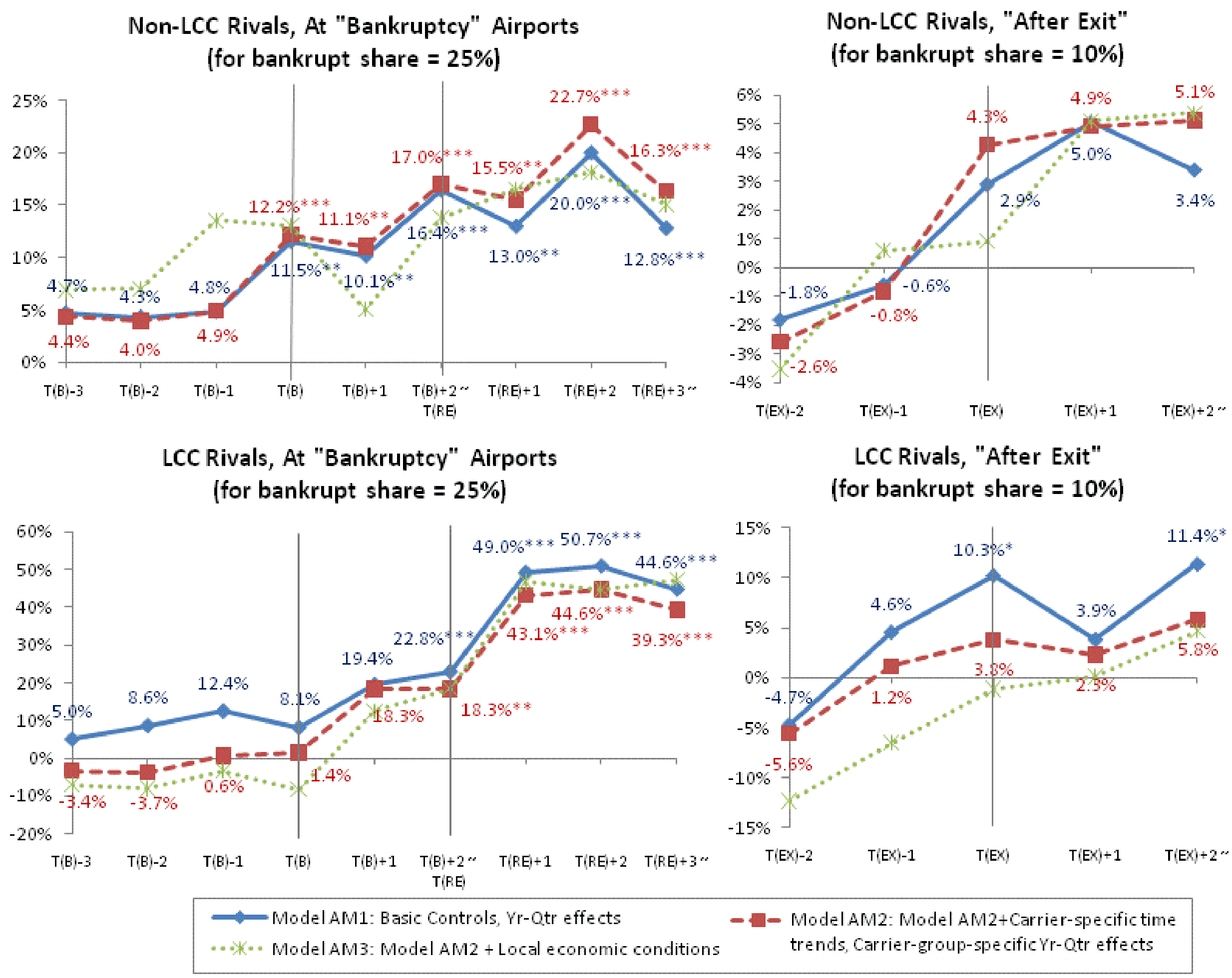

Figure 16: % Capacity Change at Airport in the Periods Surrounding "Other" Bankruptcy, Rivals: Capacity Measured by Available Seat Miles (ASM)

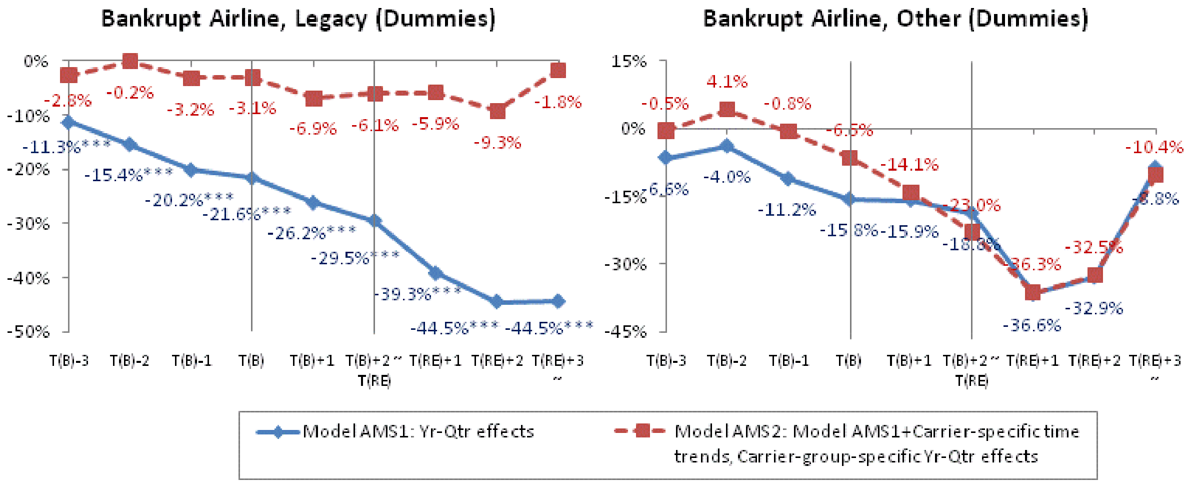

Figure 17: % Airport Market Share Change in the Periods Surrounding Bankruptcy, Bankrupt Airlines

on the route. LCC expansion by picking up the slack from rivals' bankruptcy, rather than bankruptcy itself, may toughen the competition on "bankruptcy" routes. In short, while non-LCC rivals may benefit from bankrupt airlines' capacity cutbacks as, for example, terminals and time slots are newly available for them to use, they appear to avoid the increasing competition with LCCs on "bankruptcy" routes.

In the regression results from Model AM1, the presence of a LCC ($LCCin$=1) has a significant negative relationship with capacity level whereas the estimate on the presence of Southwest ($SWin$=1) is positive and insignificant (Est.=-0.0386, SE=0.0212 for $LCCin$, and Est.=0.0272, SE=0.0228 for $SWin$). Controlling for time-variant heterogeneity between carriers (Model AM2) does not change the estimates significantly (Est.=-0.0305, SE=0.0160 for $LCCin$, and Est.=0.0142, SE=0.0177 for $SWin$). After including local economic conditions, we get a more negative and significant relationship between $LCCin$ and ASM while the estimate on $SWin$ remains the same (Est.=-0.0507, SE=0.0163 for $LCCin$, and Est.=0.0142, SE=0.0170 for $SWin$). The log-transformed value of personal income at the airport city has a positive and significant relationship with airline capacity at 1% significance level, whereas those of employment level and population at the airport city do not have a statistically significant relationship with airline capacity (Est.=0.3735, SE=0.3092 for $\log Emp$, Est.=0.4742, SE=0.1535 for $\log Inc$, and Est.=0.4535, SE=0.3257 for $\log Pop$).

Figures 17[38]-19 show the estimation results on airport market share change in the periods surrounding bankruptcy. Airport market share is measured in terms of passengers originated from the airport. Models AMS1 and AMS2 are comparable to Models MS1 and MS2 (or Models CS1 and CS2) employed in the analysis of share changes using the route sample. Although not reported here, the analyses using other measures of market presence, such as the share of available seats, the share of available seat miles, or the share of scheduled departures, led to similar results.

Figure 17 shows that bankrupt airlines maintain lower market share than normal throughout the

[38]Model AMS1: N=59,359, R^2=0.0856, Model AMS2: N=59,359, R^2=0.1770, Model AMS3: N=51,950 R^2=0.1874
T(B)=Quarter of bankruptcy filing, T(RE)=Last quarter in bankruptcy
* if significant at 10%, ** if significant at 5%, and *** if significant at 1%

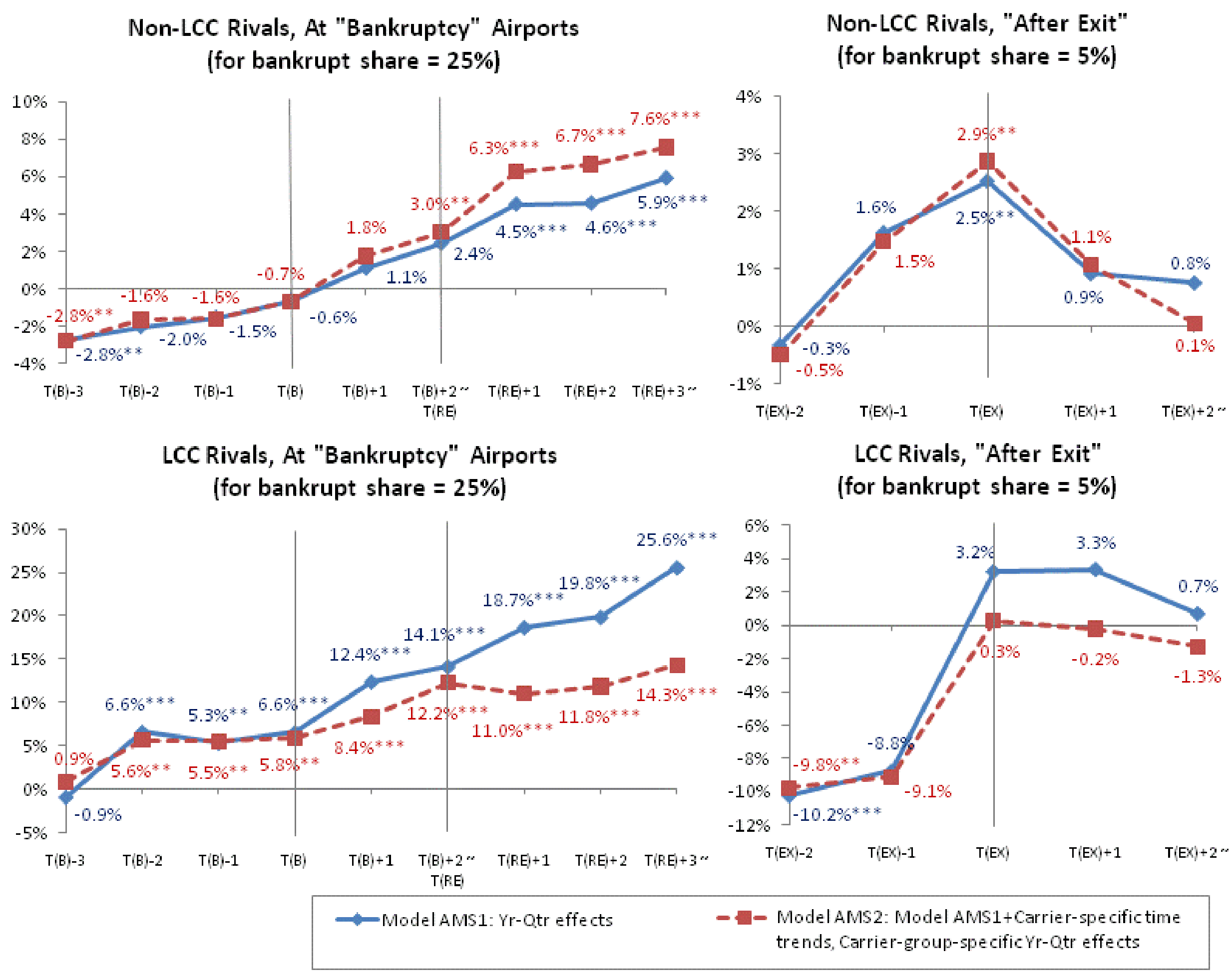

Figure 18: % Airport Market Share Change in the Periods Surrounding "Legacy" Bankruptcy, Rivals

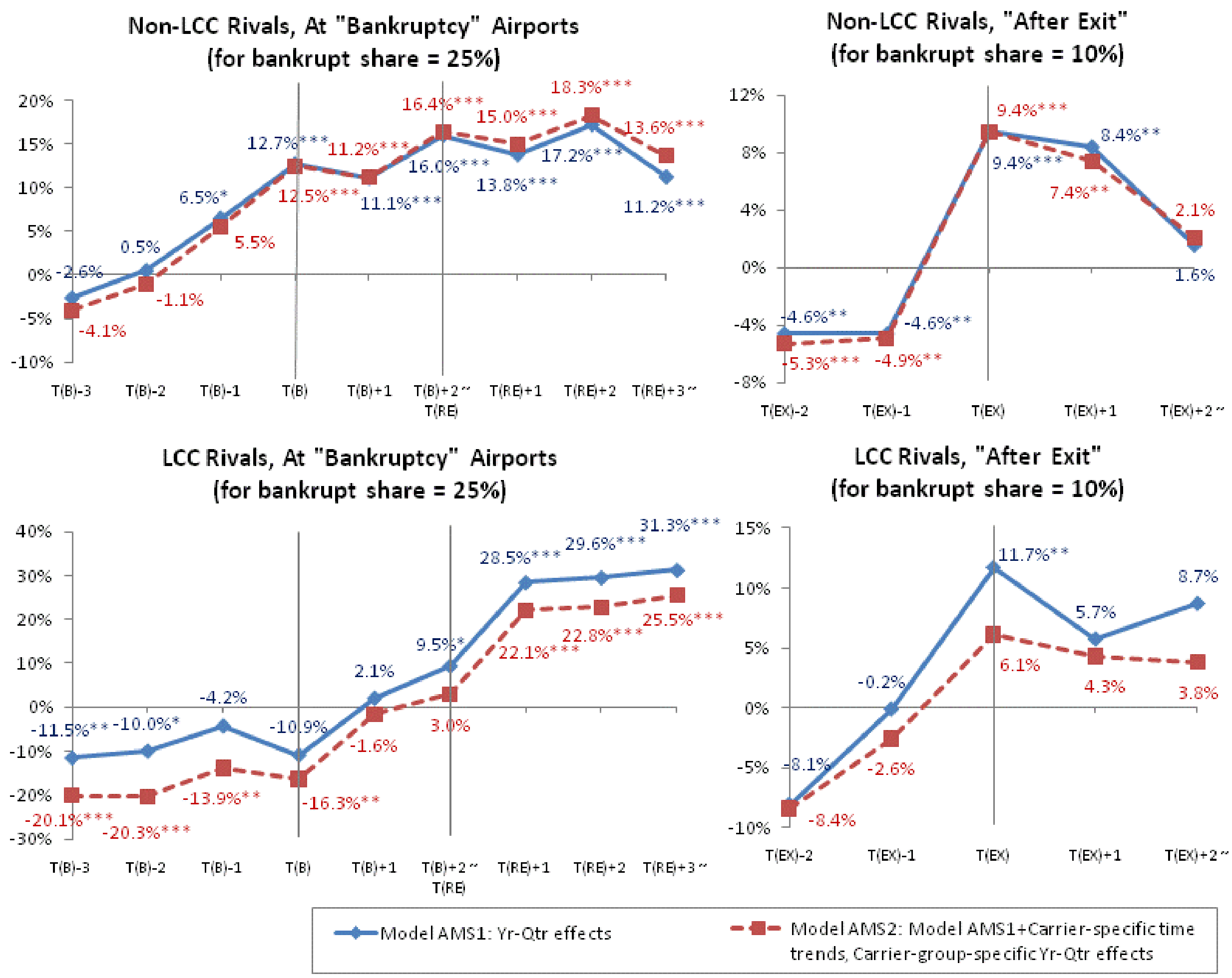

Figure 19: % Airport Market Share Change in the Periods Surrounding "Other" Bankruptcy, Rivals

periods of interest, although the market share shows signs of recovery in the long term. The market share changes for rivals during a legacy carrier's bankruptcy are consistent with the results from airline capacity changes at "bankruptcy" airports. In particular, both LCC and non-LCC rivals saw increase in market share over legacy airlines' bankruptcies. The market share increase is greater for LCC rivals.

In Figure 18, it is noteworthy that the differences between estimates from Models AMS1 and AMS2 for rivals are noticeable only after a legacy carrier filed for bankruptcy. The pattern is even more prominent for LCC rivals. This suggests that the carrier-specific time trends are over-capturing the potential systematic changes in market shares. Thus, the market share increase for LCCs will be higher than the estimates from Model AMS2 and close to those from Model AMS1 without the time trends.

In "other" bankruptcy, both LCC and non-LCC rivals show an upward trend in market share over the course of bankruptcy. However, the increase is now greater for non-LCC rivals. This may be in part because some bankrupt non-legacy airlines are acquired by legacy airlines or because LCCs may have a substantial presence already on those routes affected by "other" bankruptcy.

6.3 Does the Total Route Capacity Change?

We have seen that bankrupt airlines tend to reduce capacity over the course of bankruptcy. If outright liquidation is to eliminate costly excess capacity kept by bankrupt airlines and improve profitability for other airlines, we should expect to observe a decrease in the total route capacity levels as bankrupt airlines cut capacities or exit from a market. However, the tendency of capacity increases by LCC rivals, while bankrupt airlines' capacities cut their capacities, suggests that this may not be true. That is, when bankrupt airlines reduce capacities, LCCs may take this as an opportunity to add to their capacities, leaving the total route capacity level intact. The estimated total route capacity changes in the periods surrounding bankruptcy are presented in Figures 20 and 21.[39]

The total route capacity changes are estimated using three different models and the results are reported in Figure 20[40]. Model R1 is the basic specification with time-specific, year-quarter dummy variables. In addition, Model R2 includes the presence of a LCC and Southwest ($LCCin$ and $SWin$) for controls. Local economic conditions are added in Model R3, so the model covers only MSAs, from 1998:Q1 through 2007:Q4. As detailed in Section 1.5.1, the bankrupt-route indicators (whether there is a bankrupt airline serving the route) are multiplied by the average market share of the bankrupt airlines in normal times before affected by the bankruptcies to account for potential heterogeneity of effects depending on the different degrees of exposure to bankruptcy.

In the case of "legacy" bankruptcy, the total route capacity, measured by the number of available seats, increases right before the bankruptcy filing and then drops until the end quarter of bankruptcy in the estimation results from Models R1 and R2. Although the capacity decreased over the course of bankruptcy, given that the average "bankrupt" share is about 25%, the estimated decline is around 1%. Even when "bankrupt" share is 50%, it is only about 2%, which is no larger than the average quarterly change in the capacity on the routes covered in the sample, 4.8%. The standard deviation of quarterly capacity adjustment is about 1.9%. Borenstein and Rose (2003) reported that capacity change for two quarters before and after bankruptcy filing is no larger than usual quarterly capacity adjustment. This result is consistent with their findings. In this sense, the decrease in the capacity is statistically significant but economically insignificant. In addition, aggregate demand shocks such as September 11 (2001:Q3) led to over 10% route capacity reduction on average in the sample, so it has a much larger impact on the capacity level. After reemergence, the total route capacity level seems to recover.

In the case of "other" bankruptcy, the total route capacity seems to even increase near bankruptcy. The capacity drops steeply right after reemergence but returns to the normal level in the long term. When a bankrupt airline exits from a route, the total route capacity drops substantially, especially when the bankrupt airline has a high normal market share, and this is true both in "legacy" and "other" bankruptcy. However, the capacity level seems to rebound to the normal level eventually.

Aside from the bankruptcy effects, the presence of a LCC and/or Southwest on a route has a significant and positive relationship with the total route capacity level. In Model R2, the capacity is about 10% higher when a LCC is in, and the presence of Southwest is related to additional 15% higher capacity

[39] The tables of regression results for Models R2 and RD2 are in the Appendix, Table A4.

[40] Model R1: N=41,993, R^2=0.0814, Model R2: N=41,993, R^2=0.1116, Model R3: N=38,678, R^2=0.1160
T(B): Quarter of bankruptcy filing, T(RE): Last quarter in bankruptcy, T(EX): Quarter of bankrupt airlines' exit
* if significant at 10%, ** if significant at 5%, and *** if significant at 1%

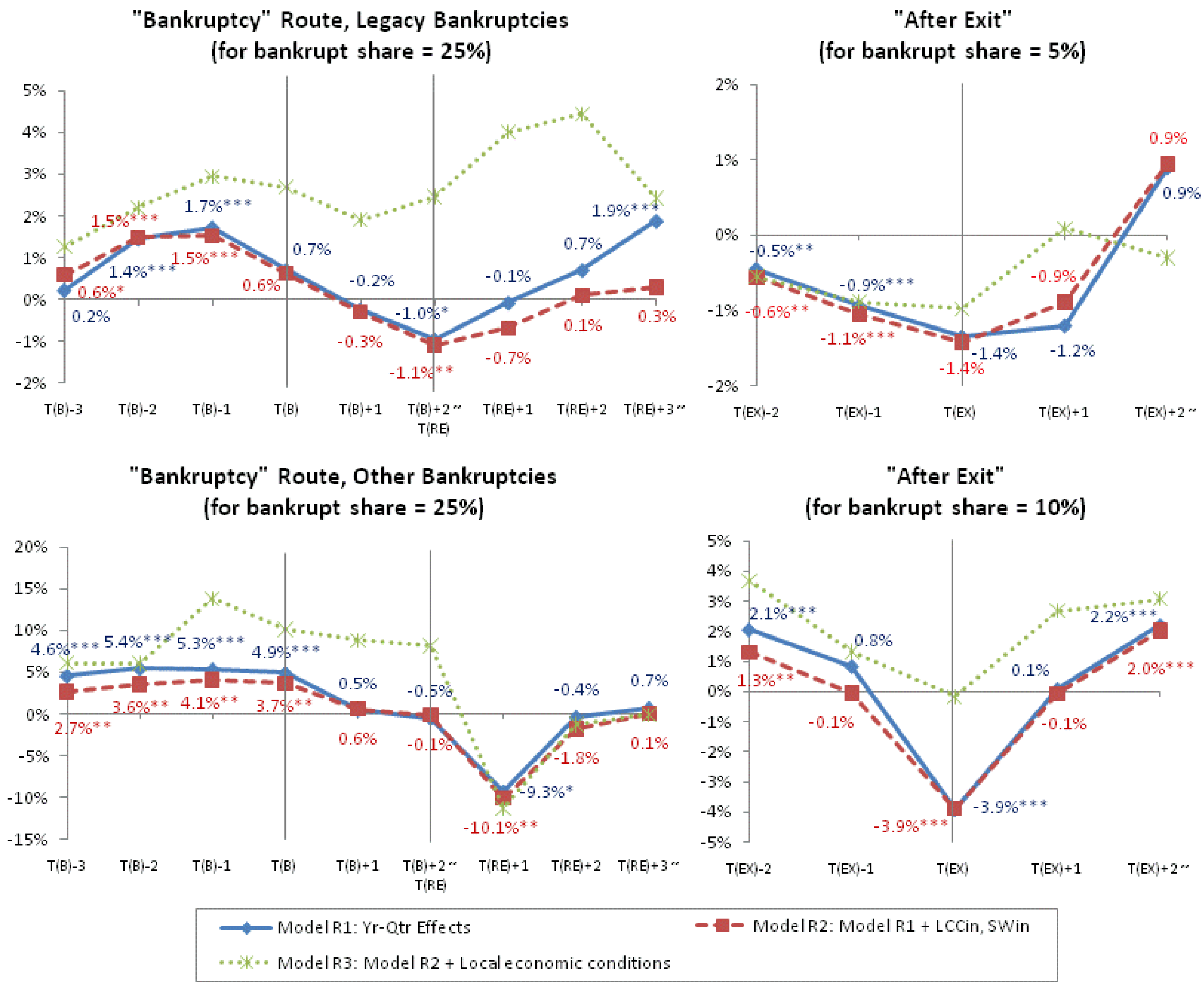

Figure 20: % Total Route Capacity Change in the Periods Surrounding Bankruptcy

level, meaning 25% capacity increase in total when Southwest is in (Est.=0.1015, SE=0.0133 for $LCCin$, Est.=0.1545, SE=0.0241 for $SWin$). Including local economic conditions does not change the estimates on the two variables meaningfully (Est.=0.1113, SE=0.0149 for $LCCin$, Est.=0.1345, SE=0.0242 for $SWin$). Among local economic conditions, only the log-transformed values of employment levels in the origin and destination cities are significant (at 1%) (Est.=0.6911, SE=0.2103 for $\log Emp\_origin$, Est.=0.6536, SE=0.2066 for $\log Emp\_dest$, Est.=0.0614, SE=0.1246 for $\log Inc\_origin$, Est.=0.0875, SE=0.1153 for $\log Inc\_dest$, Est.=-0.0089, SE=0.1841 for $\log Pop\_origin$, and Est.=0.0066, SE=0.1857 for $\log Pop\_dest$).

Moreover, the number of scheduled departures shows little change as compared to the number of available seats. Figure 21[41] shows that the number of scheduled flights even tends to increase over the course of bankruptcy, where Models RD1-RD3 are comparable to Models R1-R3. The result indicates that large aircrafts are being replaced by smaller ones on "bankruptcy" routes during the periods. As a side discussion, this suggests that a large carrier would not internalize the congestion problem and choose the optimal level of congestion because their reduction in schedules would be filled by other airlines, leaving the total congestion level unaffected.

As in the estimation results on the total route capacity measured by the number available seats, estimation on the total route capacity measured by the number of flights show that the presence of a LCC and/or Southwest on a route has a significant and positive relationship with the total route capacity level (Est.=0.1182, SE=0.0139 for $LCCin$ and Est.=0.1269, SE=0.0234 for $SWin$ in Model RD2, Est.=0.0978, SE=0.0143 for $LCCin$ and Est.=0.1527, SE=0.0233 for $SWin$ in Model RD3). Among local economic conditions, the estimated coefficients on the log-transformed values of employment levels and personal incomes in the origin and destination cities are positive and significant (Est.=0.7999, SE=0.1970 for $\log Emp\_origin$, Est.=0.7498, SE=0.1904 for $\log Emp\_dest$, Est.=0.2650, SE=0.1173 for $\log Inc\_origin$, Est.=0.3001, SE=0.1086 for $\log Inc\_dest$, Est.=0.0151, SE=0.1762 for $\log Pop\_origin$, and Est.=0.0189, SE=0.1754 for $\log Pop\_dest$).

In sum, though we observe signs of decrease in the total route capacity during bankruptcy, the size of the decrease is neither economically meaningful nor persistent on "bankruptcy" routes. Moreover, even when bankrupt airline actually ceases operation on a route, the total route capacity does not decrease. The results imply that either the overcapacity problem does not exist in the first place or the overcapacity problem, if it exists, does not get worse as a result of bankruptcy protection.

Although the total route capacity does not change meaningfully, the composition of capacity changes as bankrupt airlines reduce capacities and other airlines fill the gap. We have seen the replacement of bankrupt airlines' capacity by their rivals, especially by LCCs. From the consumer's perspective, the provider of flight services may not be important as long as there is some airline that would provide the services, that is, if the consumer does not think the quality of the flight services are significantly different. The composition of capacity, however, could matter in terms of allocative efficiency. If bankrupt airlines are relatively inefficient and are forced to cut back on capacity, then relatively efficient airlines may take the openings as an opportunity to expand. This is what we have found in the previous section. This

[41] Model R1: N=41,992, R^2=0.0598, Model R2: N=41,992, R^2=0.0877, Model R3: N=38,678 R^2=0.1853
T(B): Quarter of bankruptcy filing, T(RE): Last quarter in bankruptcy, T(EX): Quarter of bankrupt airlines' exit
* if significant at 10%, ** if significant at 5%, and *** if significant at 1%

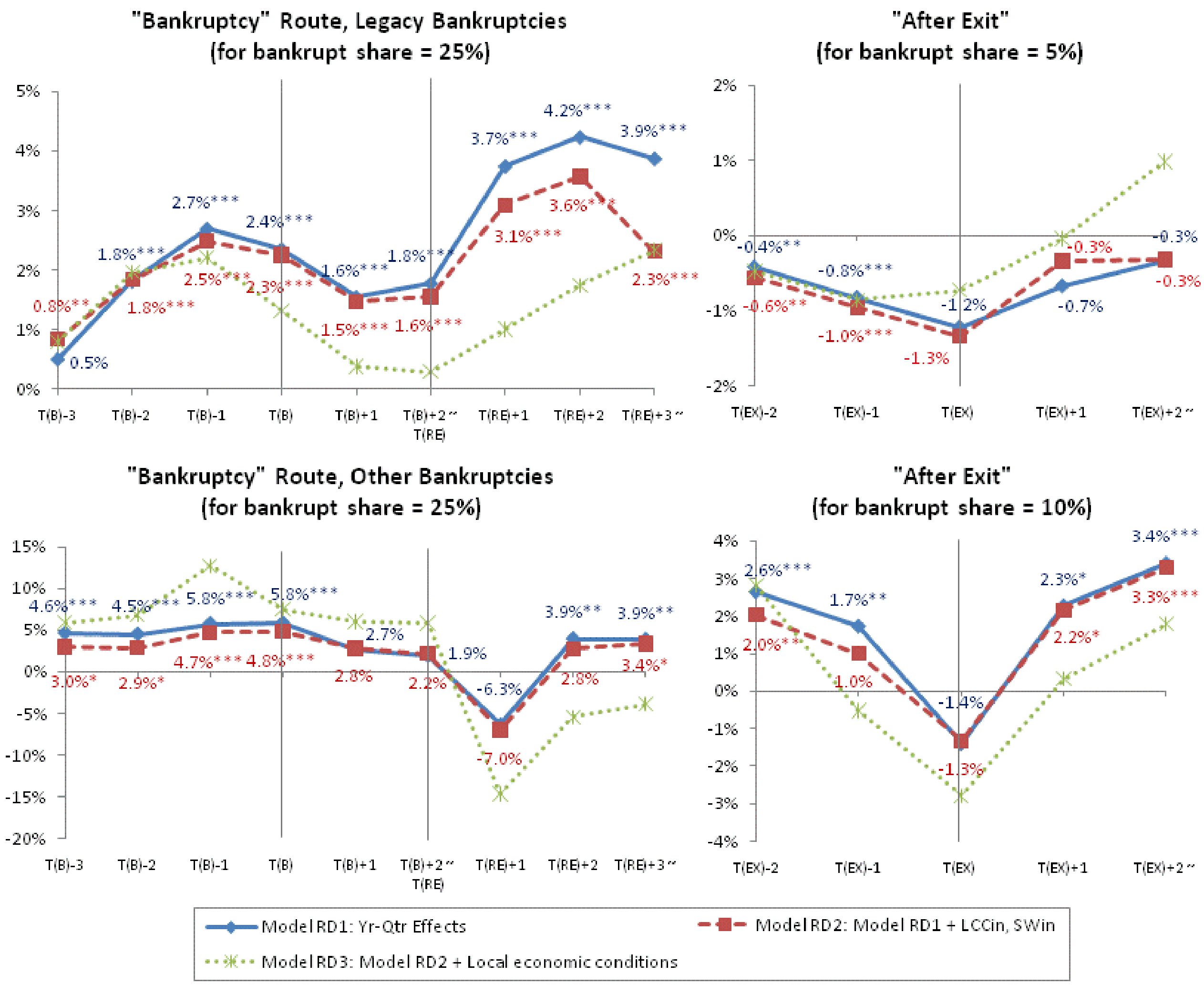

Figure 21: % Total Route Capacity Change in the Periods Surrounding Bankruptcy: Capacity Measured by Scheduled Departures

replacement will lead to a lower average cost level and higher efficiency industry-wide. The growth of LCCs spurred by rivals' bankruptcy, especially by legacy rivals' bankruptcy, leads us to the next question: what fraction of LCC expansion can be attributed to rivals' bankruptcy? Section 1.7 quantifies the effects for the quarterly 1000 most popular routes during the data period (1998:Q1-2008:Q2).

7 Calculating the Fraction of LCC Growth from Rivals' Bankruptcy

Given the long history of the airline industry since deregulation in 1978, LCCs, even with substantial cost advantage over legacy carriers, have not expanded as rapidly and extensively as expected (see Figure 22[42]). For example, LCCs' domestic passenger share is less than 5% in 1990. This raises a question: what does it take for efficient airlines to take markets from less efficient incumbents?

The airline industry is likely to have sticky market shares. Incumbent, legacy airlines can be very averse to reducing capacity for various reasons. For example, capacity reduction may not be easily reversible, that is, it may be hard for an airline to get terminals or other airport facilities back once it loses them to other airlines. Thus, keeping capacities may have an option value. Capacity reduction may have a negative impact of demands for the airline's services, as consumers value frequent flights. Also, since legacy airlines have many aircrafts and large networks, they may be able to add capacities at low costs. These reasons may be holding back the incumbent airlines from reducing capacity in normal times when they do not need any dramatic change immediately. In addition, the facilities and time slots are fixed, at least in the short term, in the airline industry. Even if LCCs can provide comparable services, it may be hard for them to get access to the resources necessary to operate as long as incumbents do not give them up. The discrete capacity reduction by incumbents then will provide immediate expansion opportunities for LCCs whose growth has been limited.

9/11, for example, was the event that urged incumbent airlines to cut capacity significantly and discretely. LCCs also reduced capacity in the aftermath of 9/11. However, the retreat did not last long. LCCs soon expanded by picking up the slack from large network airlines' capacity cutbacks. Although a bankruptcy is not as exogenous as the 9/11 shock, the risk of being liquidated may urge the airlines to cut back on capacity as substantially and discretely as 9/11. The empirical results with the route sample indicate that LCCs filled the vacuum from bankrupt airlines' retreat, suggesting that rivals' bankruptcy can be a factor that spurs LCC expansion.

Figure 23 shows the quarterly route capacity change by carrier group, as compared to the first quarter of 1998, on quarterly 1000 most travelled routes. There is a clear pattern of decline in legacy airlines' capacities and rise in LCCs' capacities in the 2000's on those routes. The correlation of the quarterly changes between legacy airlines and LCCs is about -0.8. The highly negative correlation of capacity levels between legacy and low cost airlines implies the possibility that at least part of the legacy airlines' lost capacities are replaced by LCCs.

Reverse causality of legacy airlines' bankruptcy and LCC expansion is plausible; competitive pressures from LCC expansion pushes legacy carriers to file for bankruptcy. However, we try to control for the pre-existing trend of LCC expansion, if any, by adding carrier-specific time trends. Even after removing the

[42] Source: Borenstein and Rose (2007) "How Airline Markets Work. . . Or Do They" Figure 7

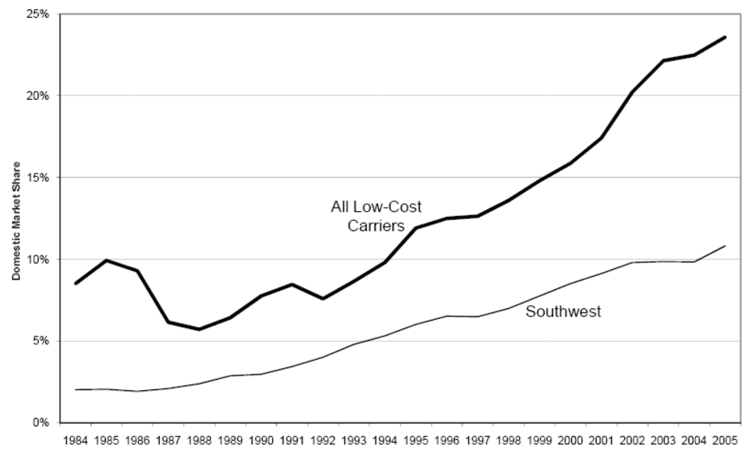

Figure 22: Domestic Market Share of Southwest and LCC, 1984-2005

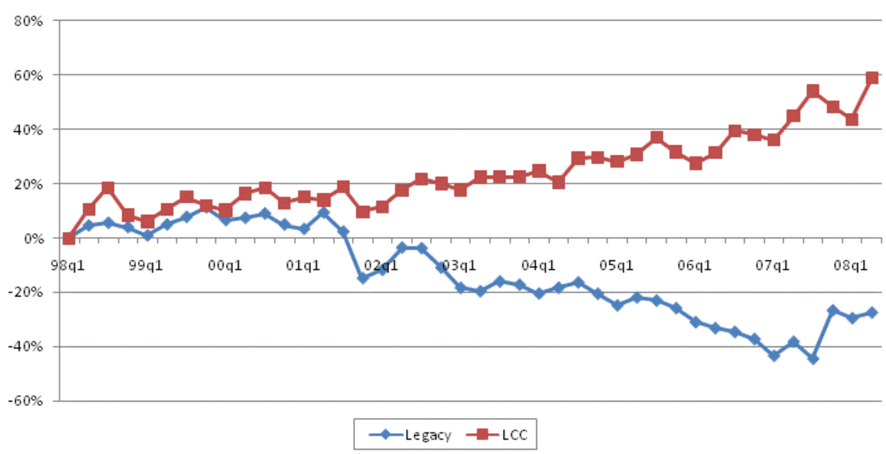

Figure 23: % Capacity Change by Carrier Group on Quarterly 1000 Most Popular Routes (base: 1998Q1)

systematic growth trend of each carrier, LCCs show the pattern of replacing bankrupt airlines' capacity. That is, whatever the reason for the bankruptcy is, bankruptcies seemed to prompt LCC rivals' expansion even further as LCCs take the openings from bankrupt airlines' capacity cutbacks upon imminent danger of liquidation as opportunities to expand. Then how large is this effect? That is, what fraction of LCC growth is spurred by rivals' bankruptcies?

Here we want to quantify the fraction of LCC growth spurred by rivals' bankruptcies. We will restrict out attention to the growth achieved *during* rivals' bankruptcies in particular. This will be called the "bankruptcy effect" in this section. Based on the estimation results from Models C1-C3, we can calculate the fraction by taking the following steps.

First, we want to focus on the capacity change for LCCs during rivals' bankruptcies. So the changes in pre- and post- bankruptcy periods will not be included to quantify the fraction of LCC growth spurred by rivals' bankruptcies. That is, the bankruptcy effect we will estimate includes the change in the periods in rival's bankruptcy or after bankrupt rival's exit ($K_{during} \equiv \{T_B,\ T_B+1,\ T_B+2\tilde{\ }T_{RE},\ T_{EX},\ T_{EX}+1,\ T_{EX}+2\tilde{\ }\}$). We begin by calculating the counterfactual capacity level of each LCC absent rivals' bankruptcies. We use the estimates from the regression on capacity with the main route sample. In particular, the estimated coefficients on LCCs during rivals' bankruptcies will be used (see Figures 6 and 7). For each combination of a LCC i, route r, and time t, the counterfactual capacity level of the LCC absent rivals' bankruptcies at that time ($\widetilde{Capacity}_{i,r,t}$) can be calculated as

$$\widetilde{Capacity}_{i,r,t} = \frac{1}{1+\sum_{k\in K1\cup K2}(\widehat{\Delta\%}^{\mathrm{lg}}_{k,r,t}+\widehat{\Delta\%}^{oth}_{k,r,t})} \cdot Capacity_{i,r,t}$$

where $\widehat{\Delta\%}^{\mathrm{lg}}_{k,r,t} \equiv \widehat{\gamma}^{lcc}_k Bshr[k]^{\mathrm{lg}}_{rt}$, $\widehat{\Delta\%}^{oth}_{k,r,t} \equiv \widehat{\lambda}^{lcc}_k Bshr[k]^{oth}_{rt}$, $Capacity_{i,r,t}$ is the actual capacity of LCC i on route r at time t, and $K1$, $K2$ are the same as defined earlier. The total bankruptcy effect until time t is then easily calculated by taking the difference between actual and counterfactual capacity level:

$$Capacity_{i,r,t} - \widetilde{Capacity}_{i,r,t} = \frac{\sum_{k\in K1\cup K2}(\widehat{\Delta\%}^{\mathrm{lg}}_{k,r,t}+\widehat{\Delta\%}^{oth}_{k,r,t})}{1+\sum_{k\in K1\cup K2}(\widehat{\Delta\%}^{\mathrm{lg}}_{k,r,t}+\widehat{\Delta\%}^{oth}_{k,r,t})} \cdot Capacity_{i,r,t}$$

Calculating the fraction of growth that occurred during rivals' bankruptcies takes a few more steps. As mentioned before, the bankruptcy effect of inducing LCC expansion on each route will come either from bankrupt airlines' capacity reduction while staying on route or from those airlines' exit from route. Thus, we need to identify the final period of each bankruptcy b on route r ($\equiv \overline{T}(b,r)$):

$$\overline{T}(b,r) = Max\{t \text{ s.t. } k(t) \in K_{during}\}$$

where $k(t)$ is the function that maps from calendar date to event period from pre-bankruptcy to post-bankruptcy. If bankruptcy ended during the data period, which is almost always the case, the final period will fall into either $[T_B+2\tilde{\ }T_{RE}]$ or $[T_{EX}+2\tilde{\ }]$. Then the bankruptcy effect accumulated from pre-bankruptcy periods ($\equiv B_{\mathrm{lg}}$ for legacy bankruptcies and B_{oth} for other bankruptcies) can be calculated by summing the individual LCC growth induced until the end of rival's bankruptcy on a route over all

LCCs (i), routes (r), and bankruptcies (b):

$$\begin{aligned} B_{\text{lg}} &= \sum_b \sum_r \sum_i \widehat{\Delta\%}^{\text{lg}}_{k(\overline{T}),r,\overline{T}} \cdot \widetilde{Capacity}_{i,r,\overline{T}} \\ B_{oth} &\equiv \sum_b \sum_r \sum_i \widehat{\Delta\%}^{oth}_{k(\overline{T}),r,\overline{T}} \cdot \widetilde{Capacity}_{i,r,\overline{T}} \end{aligned}$$

where $\overline{T} = \overline{T}(b,r)$ and $k(\overline{T})$ is the event period at $t = \overline{T}$ (which is either $[T_B + 2\tilde{\ } T_{RE}]$ or $[T_{EX} + 2\tilde{\ }]$ in most cases). The next step is to take out the changes in pre-bankruptcy periods to capture the rivals'-bankruptcy-motivated LCC growth occurred during rivals' bankruptcies:

$$\begin{aligned} \Delta Capacity_{\text{lg}} &= B_{\text{lg}} - \sum_b \sum_r \sum_i \widehat{\Delta\%}^{\text{lg}}_{k(T_B(b)-1),r,T_B(b)-1} \cdot \widetilde{Capacity}_{i,r,T_B(b)-1} \\ \Delta Capacity_{oth} &= B_{oth} - \sum_b \sum_r \sum_i \widehat{\Delta\%}^{oth}_{k(T_B(b)-1),r,T_B(b)-1} \cdot \widetilde{Capacity}_{i,r,T_B(b)-1} \end{aligned}$$

where $T_B(b)$ is the quarter of filing for bankruptcy b (so $T_B(b) - 1$ is the last period prior to actual bankruptcy filing of bankruptcy event b). Finally, the fraction of LCC growth during the data time periods spurred by rivals' bankruptcy can be calculated by dividing the estimated bankruptcy effects by the actual LCC growth during the same period:

$$\begin{aligned} Fraction^{\text{lg}} &= \frac{\Delta Capacity_{\text{lg}}}{\sum_{t=1998Q1}^{2008Q2} \sum_r \sum_i (Capacity_{i,r,t} - Capacity_{i,r,t-1})} \\ Fraction^{oth} &= \frac{\Delta Capacity_{oth}}{\sum_{t=1998Q1}^{2008Q2} \sum_r \sum_i (Capacity_{i,r,t} - Capacity_{i,r,t-1})} \end{aligned}$$

Table 1.7: Fraction of LCC Growth from Rivals' Bankruptcy

Bankruptcy	Model C1	Model C2	Model C3
	(98q1 - 08q2)	(98q1 - 08q2)	(98q1 - 07q4, MSA only)
Legacy	16.88%	11.26%	11.10%
Other	1.18%	1.48%	-2.40%
Total	18.06%	12.74%	8.70%

Model C1 : Basic (Yr-Qtr specific time effects, $LCCin$, $SWin$)

Model C2 : Model C1+ Carrier-specific time trends, Carrier-group-specific Yr-Qtr effects

Model C3 : Model C2 + Local economic conditions

The sum of the two fractions can be interpreted as the bankruptcy effect from all rival bankruptcies. Table 1.7 shows the estimated bankruptcy effects. The estimated fraction of LCC growth explained by responses to rivals' bankruptcy ranged from 13 to 18% depending on which model to use. If we disentangle the effect into legacy bankruptcies and other bankruptcies, most of the LCC growth spurred by rivals' bankruptcy is from legacy bankruptcies. In particular, the fraction explained by legacy rivals' bankruptcies is ranged from 15.5 to 16.9%. We can see that the fraction is significant, suggesting that barriers are not negligible in the airline industry.

8 Conclusion

This paper contributes to our understanding in two areas of research. First, the paper gives us a lesson on the link between financial conditions and market competition by examining the claim of potential harms of Chapter 11 bankruptcy to rivals. Second, the findings that LCCs replace bankrupt, incumbent legacy airlines and the significant fraction of LCC growth occurred during legacy airlines' bankruptcy have implication for barriers to entry and expansion, persistence of market structure, and firm growth.

We begin by studying whether bankrupt airlines harm rivals by engaging in aggressive pricing and contributing to the overcapacity problem, if it exists. We found little evidence supporting the claim that bankrupt airlines harm efficient LCC rivals and the industry. Bankrupt airlines do cut fares, but they also cut capacities. During the same period, their LCC rivals cut fares a little in the beginning of the bankruptcy, but they also expand capacities significantly, increasing their market presence. Considering the finding that the total route capacity is largely unaffected by bankruptcy, it implies that LCCs replace capacities of bankrupt airlines, especially those of bankrupt legacy airlines.

The empirical results do not support the claim that Chapter 11 harms bankrupt airlines' rivals and the industry by allowing a bankrupt airline to shed costs and put competitive pressure on efficient rivals, as bankrupt airlines do not appear to harm the profitability and financial health of LCCs. However, if the bankrupt airlines were to have been liquidated immediately and LCCs could have expanded operations substantially and quickly at low cost, then the efficient carriers' growth might have been even greater. In this sense, the rationale for Chapter 11 will depend on the capability of bankrupt airlines to cut costs down to the level comparable to LCCs.

The additional question naturally follows from the empirical results. The main lesson from the findings is that LCCs expand during bankruptcies of rivals, especially those of legacy rivals. This pattern suggests the existence of barriers that have limited LCC growth. The immediate and substantial capacity reduction that bankrupt or near-bankruptcy airlines are forced to take will present new opportunities for efficient airlines to expand. How large a fraction of LCC growth is spurred by rivals' bankruptcy? Section 1.7 estimates the fraction to quantify the effect of rival airlines' bankruptcy on LCC growth. The estimated fraction ranged from 13 to 18%, and, moreover, most of the growth spurred by rivals' bankruptcy has been achieved during legacy airline bankruptcies. As LCCs expand while bankrupt legacy airlines shrink, the competitive pressure will rise. If bankrupt airlines reemerge as nimbler and stronger competitors with lower cost structures, they will add even more competitive pressure. So it is natural to expect more competition after, rather than during, bankruptcy, which is shown in the results from the analysis on fares.

While the paper suggests no special harm of bankruptcy protection to LCC rivals, we need to exercise more caution when it comes to drawing policy implications. We do not compare the actuals directly with the counterfacutals in which Chapter 11 option is not available and every bankrupt airline would have been liquidated immediately. We compare the actuals with the counterfactuals in which the bankrupt airlines would have operated as in normal times and thereby draw implications about whether the existence of the airlines operating under bankruptcy protection is harmful to rivals and the industry. So, if the elimination of Chapter 11 changes firms' behavior even when they are not under financial distress, this paper does not tell us in what direction the effect would go.

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10 Appendix

The estimation results are reported as a graph in the text. The estimated coefficients for main models are reported in this appendix. Table 1.1A is on median fare and Table 1.2A is on capacity on the 1000 most popular routes. Table 1.3A is on capacity at the 200 most popular airports. Lastly, Table 1.4A is on the total route capacity measured by the number of seats or the number of scheduled departures. All models except for the model for the total route capacity include time-specific effects (i.e. year-quarter dummy variables), carrier-specific linear time trends, and time-specific effects for each carrier-group (i.e. year-quarter-carrier group dummy variables; carrier group is a legacy, a LCC, or other).

In the first column labeled as “Variable”, $[T_B - 3]$ - $[T_B - 1]$ are the pre-bankruptcy period, $[T_B]$ - $[T_B + 2\tilde{~}T_{RE}]$ are during bankruptcy, $[T_{RE} + 1]$ - $[T_{RE} + 3\tilde{~}]$ are the post-bankruptcy period after reemergence, $[T_{EX} - 2]$ - $[T_{EX} - 1]$ are the quarters before a bankrupt airline’s exit from a route, and $[T_{EX}]$ - $[T_{EX} + 2\tilde{~}]$ are the quarters after the exit. The column labeled as “Bankrupt” means a carrier is bankrupt and the one labeled as “Rival_nlcc” (or “Rival_lcc”) indicates that a carrier is a non-LCC (or LCC) that serves a route where a bankrupt airline serves. The columns under “Legacy Bankruptcy” are for legacy airline bankruptcies whereas the columns under “Others” are for other non-legacy airline bankruptcies. The intersection between “Bankrupt” and an event period ($[T_B - 3]$ - $[T_{RE} + 3\tilde{~}]$) shows the estimated coefficient on the dummy variable indicating a bankrupt carrier in the event period. For example, the intersection between “Bankrupt” and $[T_B]$ is the estimated coefficient on the indicator of quarter of bankrupt filing when a carrier is bankrupt. For bankrupt airlines’ rivals (“Rival_nlcc” or “Rival_lcc”), the intersection is the estimated coefficient on the interaction between bankrupt airlines’ normal market share (from the past) and the indicator of bankrupt airlines’ rival. Details on the construction of these variables are in Table 1.5 in Section 1.5.1. So, the estimated coefficients are not directly comparable to those for bankrupt airlines (“Bankrupt”). In the text, we multiplied the estimated coefficients with average normal market share of bankrupt airlines. $D\_fl, q1$-$D\_fl, q3$ are the quarter dummy variables for Florida. The reported R^2 is the within-R^2.

Table 1.1A: Estimation Result - Median Fare

Model F2, Route Sample

Dependent Var.	$\log Med\_fare$					
	Legacy Bankruptcy			Others		
Variable	Bankrupt	Rival_nlcc	Rival_lcc	Bankrupt	Rival_nlcc	Rival_lcc
$[T_B - 3]$	-.0192***	.0106	-.0039	.0049	-.0851***	-.0795**
	(.0048)	(.0117)	(.0132)	(.0080)	(.0273)	(.0354)
$[T_B - 2]$	-.0294***	.0015	-.0224	-.0122	-.0078	-.0148
	(.0055)	(.0134)	(.0156)	(.0088)	(.0267)	(.0337)
$[T_B - 1]$	-.0542***	-.0352***	-.0134	-.0159	-.0680**	-.0849***
	(.0055)	(.0126)	(.0145)	(.0099)	(.0291)	(.0316)
$[T_B]$	-.0706***	-.0280**	-.0451***	-.0506***	-.0621**	-.0644*
	(.0062)	(.0140)	(.0156)	(.0111)	(.0305)	(.0339)
$[T_B + 1]$	-.0559***	-.0287**	-.0203	-.0916***	.0496	.0271
	(.0062)	(.0143)	(.0178)	(.0159)	(.0357)	(.0528)
$[T_B + 2\tilde{\ }T_{RE}]$	-.0442***	.0530***	.0022	-.0756***	.0585*	.0232
	(.0057)	(.0115)	(.0159)	(.0207)	(.0329)	(.0423)
$[T_{RE} + 1]$	-.0526***	.0975***	-.0244	-.0399	.1351***	-.2723***
	(.0072)	(.0139)	(.0205)	(.0271)	(.0389)	(.0941)
$[T_{RE} + 2]$	-.0506***	.0541***	-.0746***	-.0762**	-.0671	-.2268
	(.0073)	(.0144)	(.0207)	(.0362)	(.0553)	(.1456)
$[T_{RE} + 3\tilde{\ }]$	-.0337***	-.0654***	-.0453**	-.1738***	-.1189***	-.1503
	(.0067)	(.0138)	(.0200)	(.0395)	(.0419)	(.0914)
$[T_{EX} - 2]$		.0556	-.0149		-.1412***	-.1652***
		(.0502)	(.0856)		(.0368)	(.0496)
$[T_{EX} - 1]$		.1085**	-.0420		-.1099***	-.3726***
		(.0526)	(.0701)		(.0405)	(.0573)
$[T_{EX}]$		.4275**	-.2118		-.1070**	-.2866***
		(.1696)	(.2407)		(.0444)	(.0646)
$[T_{EX} + 1]$		.1470	-.2507		-.2029***	-.2029***
		(.1528)	(.2887)		(.0549)	(.0719)
$[T_{EX} + 2\tilde{\ }]$		-.1250	-.5096***		-.1185***	.0125
		(.1127)	(.1468)		(.0430)	(.0381)
$LCCin$	-.0886*** (.0064)					
$SWin$	-.0820*** (.0085)					
$Network$	.0930*** (.0287)					
$Direct$	.0348*** (.0113)					
$D\_fl, q1$	.0235*** (.0028)					
$D\_fl, q2$	-.0013 (.0023)					
$D\_fl, q3$	-.0624*** (.0030)					
$Constant$	4.973*** (.0149)					
R^2	0.1528					
N	182,437					

Bankrupt: bankrupt airline, Rival_nlcc: non-LCC rivals, Rival_lcc: LCC rival

Robust Cluster SE reported in parentheses. N: Sample size

* Significant at 10 %, ** Significant at 5 %, *** Significant at 1 %

Table 1.2A: Estimation Result - Capacity (Number of Available Seats)

Model C2, Route Sample

Dependent Var.	$\log N\_seats$					
	Legacy Bankruptcy			Others		
Variable	Bankrupt	Rival_nlcc	Rival_lcc	Bankrupt	Rival_nlcc	Rival_lcc
$[T_B - 3]$	-.0522**	-.1395	-.1797**	.0607*	.2648*	.4086**
	(.0252)	(.1104)	(.0885)	(.0354)	(.1574)	(.1811)
$[T_B - 2]$	-.0815***	-.1707	.0663	.0975***	.1854	.7303***
	(.0284)	(.1160)	(.0757)	(.0304)	(.1191)	(.1740)
$[T_B - 1]$	-.1312***	-.2048*	.0494	-.1265***	.3628**	.4964***
	(.0351)	(.1108)	(.0736)	(.0472)	(.1619)	(.1794)
$[T_B]$	-.1081***	-.3955***	.0406	-.1346**	.0879	1.2216***
	(.0347)	(.1103)	(.0757)	(.0630)	(.2767)	(.3135)
$[T_B + 1]$	-.1145***	-.5826***	.1112	-.3963***	.4601**	.2822
	(.0349)	(.1282)	(.0736)	(.0738)	(.1933)	(.2903)
$[T_B + 2\tilde{\ }T_{RE}]$	-.0777***	-.2172*	.2306***	-.4716***	.5247***	.5207*
	(.0291)	(.1178)	(.0765)	(.0781)	(.1723)	(.2719)
$[T_{RE} + 1]$	-.0525	-.0932	.3262***	-.8905***	.0241	1.5813***
	(.0436)	(.1233)	(.1002)	(.1077)	(.1437)	(.3242)
$[T_{RE} + 2]$	-.1759***	-.1847	.3803***	-.6446***	.2755*	1.9635**
	(.0453)	(.1280)	(.0993)	(.0770)	(.1456)	(.9433)
$[T_{RE} + 3\tilde{\ }]$	-.1975***	-.3837***	.3563***	-.3053***	.8851***	1.4676**
	(.0441)	(.1255)	(.1007)	(.0848)	(.1403)	(.6378)
$[T_{EX} - 2]$		-.8013	-1.0410		-.3711*	.3735**
		(.7069)	(.8227)		(.1993)	(.1712)
$[T_{EX} - 1]$		-1.1191*	.7795		-.3125	1.4321***
		(.6655)	(.7714)		(.2459)	(.3274)
$[T_{EX}]$		-.3293	.0232		.7131***	1.0758***
		(1.0597)	(.7597)		(.2398)	(.2927)
$[T_{EX} + 1]$		-.8454	1.6176**		.6396	1.6503***
		(1.1406)	(.7903)		(.5489)	(.2737)
$[T_{EX} + 2\tilde{\ }]$		.0061	1.9087***		1.4034***	1.3407***
		(1.1222)	(.5371)		(.2842)	(.2011)
$LCCin$	.0293 (.0222)					
$SWin$	.0793** (.0349)					
$D\_fl, q1$	.0747*** (.0126)					
$D\_fl, q2$	-.0092 (.0118)					
$D\_fl, q3$	-.0437*** (.0129)					
$Constant$	3.526*** (.0302)					
R^2	0.0828					
N_sgmt	82,333					

Bankrupt: bankrupt airline, Rival_nlcc: non-LCC rivals, Rival_lcc: LCC rival

Robust Cluster SE reported in parentheses. N_sgmt: Sample size

* Significant at 10 %, ** Significant at 5 %, *** Significant at 1 %

Table 1.3A: Estimation Result - Capacity (Available Seat Miles)

Model AM2, Airport Sample

Dependent Var.	log ASM					
	Legacy Bankruptcy			Others		
Variable	Bankrupt	Rival_nlcc	Rival_lcc	Bankrupt	Rival_nlcc	Rival_lcc
$[T_B - 3]$	.0072	.0216	.0541	.0240	.0860	-.4202***
	(.0210)	(.0512)	(.0801)	(.0309)	(.1246)	(.1490)
$[T_B - 2]$	.0043	.0392	.2335**	.0218	.1174	-.4658**
	(.0197)	(.0595)	(.0998)	(.0323)	(.1268)	(.2174)
$[T_B - 1]$	-.0183	.0263	.2368**	-.0605	.1877	-.3647
	(.0225)	(.0613)	(.0949)	(.0423)	(.1408)	(.2614)
$[T_B]$	-.0029	.0251	.2236**	-.1138**	.5153***	-.4297
	(.0238)	(.0579)	(.0911)	(.0462)	(.1699)	(.3255)
$[T_B + 1]$	-.0455	.0778	.2924***	-.0798	.3572**	.0348
	(.0288)	(.0624)	(.1082)	(.0685)	(.1750)	(.2592)
$[T_B + 2\tilde{}T_{RE}]$	-.0680***	.0843	.3930***	-.2475***	.4785***	.1695
	(.0243)	(.0559)	(.1009)	(.0884)	(.1561)	(.2191)
$[T_{RE} + 1]$	-.0514	.2382***	.3027***	-.2734*	.6338***	1.0926***
	(.0336)	(.0615)	(.1133)	(.1489)	(.2154)	(.2248)
$[T_{RE} + 2]$	-.1035***	.2250***	.3727***	-.2192	.9276***	1.1131***
	(.0347)	(.0626)	(.1203)	(.1583)	(.1573)	(.2450)
$[T_{RE} + 3\tilde{}]$	-.0281	.2400***	.4278***	.0147	.6631***	1.0434***
	(.0313)	(.0613)	(.1361)	(.1731)	(.1373)	(.2263)
$[T_{EX} - 2]$		.0590	-2.3607**		-.2132	-.6578
		(.2423)	(.9418)		(.1951)	(.5125)
$[T_{EX} - 1]$		.4128***	-1.8611		-.0221	.0764
		(.2058)	(1.2954)		(.2287)	(.3999)
$[T_{EX}]$		.4926***	-.3215		.5447**	.2123
		(.2282)	(.7007)		(.2312)	(.4292)
$[T_{EX} + 1]$		.1170	-.5160		.5398*	.1434
		(.2546)	(.6878)		(.2907)	(.3685)
$[T_{EX} + 2\tilde{}]$		.1551	-.4271		.5044	.4404
		(.2174)	(.5456)		(.3133)	(.4490)
$LCCin$	-.0305* (.0160)					
$SWin$	.0141 (.0177)					
$D\_fl, q1$	.0965*** (.0198)					
$D\_fl, q2$	-.0031 (.0122)					
$D\_fl, q3$	-.1391*** (.0201)					
$Constant$	-3.282*** (.0269)					
R^2	0.1750					
N_sgmt	59,359					

Bankrupt: bankrupt airline, Rival_nlcc: non-LCC rivals, Rival_lcc: LCC rival

Robust Cluster SE reported in parentheses. N_sgmt: Sample size

* Significant at 10 %, ** Significant at 5 %, *** Significant at 1 %

Table 1.4A: Estimation Result - Total Route Capacity

Models R2-RD2, Route Sample

Dependent Var.	$\log N\_seats\_all$		$\log N\_flights\_all$	
	"Bankruptcy" routes		"Bankruptcy" routes	
Variable	Legacy bankruptcy	Other	Legacy bankruptcy	Other
$[T_B-3]$	.0236**	.1070**	.0338**	.1209*
	(.0140)	(.0526)	(.0136)	(.0670)
$[T_B-2]$	.0599***	.1421**	.0734***	.1129*
	(.0155)	(.0629)	(.0154)	(.0628)
$[T_B-1]$	.0611***	.1803**	.0996***	.1960***
	(.0162)	(.0709)	(.0161)	(.0699)
$[T_B]$	.0245	.1504**	.0898***	.1947***
	(.0177)	(.0626)	(.0169)	(.0629)
$[T_B+1]$	-.0126	.0211	.0583***	.1118
	(.0184)	(.0695)	(.0183)	(.0742)
$[T_B+2\tilde{\ }T_{RE}]$	-.0438**	.0005	.0619***	.0930
	(.0206)	(.0854)	(.0202)	(.0859)
$[T_{RE}+1]$	-.0275	-.4043**	.1233***	-.2789
	(.0242)	(.1943)	(.0241)	(.1898)
$[T_{RE}+2]$	.0037	-.0726	.1429***	.1107
	(.0240)	(.0793)	(.0239)	(.0734)
$[T_{RE}+3\tilde{\ }]$	.0114	.0026	.0922***	.1313*
	(.0256)	(.0631)	(.0242)	(.0742)
$[T_{EX}-2]$	-.0242***	.0053	-.0330***	.0252
	(.0069)	(.0165)	(.0081)	(.0171)
$[T_{EX}-1]$	-.0410***	.0012	-.0393***	.0207
	(.0117)	(.0148)	(.0120)	(.0153)
$[T_{EX}]$	-.2772	-.3904***	-.2623	-.1331
	(.2380)	(.0957)	(.2168)	(.1112)
$[T_{EX}+1]$	-.1726	-.0095	-.0639	.2140*
	(.2194)	(.0809)	(.2184)	(.1153)
$[T_{EX}+2\tilde{\ }]$	.1956	.1981***	-.0587	.3257***
	(.5222)	(.0626)	(.5387)	(.0689)
$LCCin$	.1015*** (.0132)		.1183*** (.0139)	
$SWin$	.1548*** (.0241)		.1269*** (.0234)	
$D\_fl,q1$	.0661*** (.0064)		.0493*** (.0068)	
$D\_fl,q2$	.0093** (.0036)		.0137*** (.0043)	
$D\_fl,q3$	-.0533*** (.0063)		-.0252*** (.0057)	
$Constant$	4.659*** (.013)		6.623*** (.012)	
R^2	0.1115		0.0875	
N	41,993		41,993	

Robust Cluster SE reported in parentheses. N: Sample size

* Significant at 10 %, ** Significant at 5 %, *** Significant at 1 %